THE SEPTEMBER SCIENTIFIC MONTHLY

EDITED BY J. MCKEEN CATTELL

THE SCIENCE PRESS

LANCASTER, PA.—GRAND CENTRAL TERMINAL, N. Y. CITY—GARRISON, N. Y.

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Vol. XXXI, No. 3 SEPTEMBER, 1930 Whole No. 180

The Scientific Monthly

An Illustrated Magazine Devoted to the Diffusion of Science

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WARE CATTELL, Associate Editor

Published by THE SCIENCE PRESS
LANCASTER, PA.—NEW YORK, N. Y., Grand Central Terminal—GARRISON, N. Y.

Single Number, 50 Cents Yearly Subscription, $5.00

Entered as second-class matter at the post office at Lancaster, Pa., July 18, 1923, under the Act of March 3, 1879.

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THE SCIENTIFIC MONTHLY

SEPTEMBER, 1930

MEDICAL SKETCHES IN THE ORIENT[1]

By Dr. ALFRED C. REED

PROFESSOR OF TROPICAL MEDICINE, UNIVERSITY OF CALIFORNIA

Two dominant impressions develop in the mind of one who travels in the Orient with some knowledge of its history and experience of its races. So powerful are these impressions that they seem to throw new light on the problems of disease and sanitation in the Orient, and at the same time to offer a much-needed clue in finding the road to medical improvement. By medical improvement is meant betterment in all that makes for physical, mental and spiritual health. These impressions receive confirmation from each of the great social divisions of the Orient—China, Japan, Malaya and the Pacific Islands, India and the Moslem world.

The first impression is of the deep-rooted Oriental significance of the unity of race and religion. This leads to serious and pregnant situations in government, in business, in the social fabric and in matters of health. Religious ideas become paramount in health programs and in individual care of the sick. Health matters, even more than in the Occident, are influenced by the concerns of business or economics, of education, of social customs and relations which are based chiefly in religion, and, above all, by religion itself. This will be illustrated in the pages following. Unity of racial culture and racial religion gives strength to each, and what affects one draws reaction from the other. This has a paramount bearing on any proposal for medical improvement.

The second impression is of the boundless, largely chaotic but essentially ethnic urge of nationalism. It has almost a biologic quality. It is often ill advised; it may lack leaders who combine vision, rectitude and ability. It may be inchoate in the minds of the population. But it is a seething yeasty brew that is heady, to be sure, but much more is an evidence of the impact of Occidentalism and its individualism on Oriental collectivism. The nationalistic urge has depth and primitive strength. It rises from deeps but little known or understood in the West. Probably it is irrepressible and inevitable. Certainly it is conditioned closely by the first of our impressions, that of the unity of race, culture and religion in the Orient. Out of the interplay of these two great sets of forces—the one unreasoning, somewhat subconscious, instinctive and age-old, the other breeding the germ of intellect, emerging into full consciousness and lately developed—out of this titanic and elemental interplay are to develop conditions and situations which the Western scientist and physician can only view with the most profound interest and sympathy.

No appreciation of the Oriental attitude toward health and disease is possible without at least a slight under-

[1] From the Pacific Institute of Tropical Medicine, San Francisco.

COUNTRY VILLAGE BELOW MADRAS

NOTE RACIAL TYPES IN GROUP OF GIRLS AS SHY AS RABBITS.

standing of the basis of local native psychology. None exalt the individual. All decry the value of human living. All in theory are highly spiritual and intellectual, in practice are sordid and easily descend to magic and superstition. Similar conditions are not unknown in the Western world.

In ancient years in China, so the story runs, the Son of Heaven lay grievously ill, beset by a hundred thousand devils who were fast stealing away his very life. In vain the astrologers, the magicians, the wise men, geomancers and physicians sought to turn the tide. Finally the sick emperor called on the two generals of his army, who had never failed him, to come to his aid. The one entered the sick chamber and said "Hah" in a loud tone of voice and by the blast of his breath slew fifty thousand devils. The other exclaimed "Hoong" in a loud voice, and at the blast of his breath the other fifty thousand were slain and the emperor was restored to health. From that day to this General Hoong and General Hah have been the guardians of the gate of every Chinese household, and the fierce aspects of these gate gods painted on the doors keep out the swarming disease devils of an incautious imagination. All this is not so different from our own mad-stones and saving relics, whether of rabbit-foot or saint.

Not only do the Chinese live under the medical domination of magic and the dragons of air, earth and water, but even now Confucianism is powerful. A large part of the life of China is lived on its waterways. Rivers, canals and oceans bear on their broad waters a population numbering many millions and even yet afford the chief means of transport. The sampan and junk are essential for the life of China. Each of them has, painted on its bow, eyes to

see where it is going—a perfectly logical procedure when every object may be the embodiment of a spirit. Each junk and houseboat is steered by a steersman who sits and faces astern and steers by landmarks he has passed. All China even yet is trying to steer by landmarks in the past because Confucius taught that perfection lay in the past. This tacit system of belief has worked with peculiar force to oppose Western ideas of medicine, sanitation and health. Just as with our religion, so our modern medicine must be studied by the Chinese and then adapted by them to their own needs. Faster it can not go and no other road can prove permanent. Nationalistic growing pains will doubtless continue for a generation or more, and then from the ashes of the old backward-looking middle kingdom will appear, phenix-like, a great Far Western nation, expressing the fine foundation and capability of this great race.

Chinese knowledge of disease in some cases is quite accurate and very ancient. A terrible curse of the Orient and all the tropics is rabies. The fact that many of the native races do not believe in the existence of disease or the reality of disease transfer does not prevent rabies being prevalent. Excellent Pasteur institutes are found in the chief cities from Cairo to Shanghai. In these is manufactured the serum which prevents rabies. It is not a cure, but is a sure preventive. The people know rabies. From the earliest recorded times, the Chinese have associated it with the infected saliva of mad dogs. Dog rabies is rampant. Human rabies is frequently seen because the specific Pasteur treatment is not available or is used too late.

China learned the dangers of smallpox many centuries ago. Inoculation has been practiced since the eleventh century, it being considered that smallpox inoculated into healthy children was less dangerous than when contracted by natural infection. Almost the entire population in some sections is pock-marked. The death-rate is high, the suffering severe and the after-effects are often crippling and invaliding. These facts were discovered by sad experience, and explain the great popularity of vaccination all over China since its introduction in 1805 at Canton by Dr. Alexander Pearson, of the Honorable East India Company.

All over China tuberculosis, especially in the pulmonary form, is nearly universal. Damp, sealed houses and the practice of spitting on the floor are to blame. When cold weather comes, every crevice is sealed with paste and paper strips. Charcoal braziers are the usual form of heating. Carbon monoxide poisoning is common and frequently entire families die. Then it is customary simply to add more garments as cold increases. Cold, damp houses are not conducive to bathing and personal cleanliness. Droplet infection of the air in such houses is very heavy. Not only tuberculosis, but pneumonic plague and influenza are spread with great ease by this means. A complete absence of what we call "sanitary sense" is usually one of the surprises lying in wait for the newcomer to Oriental lands. Transmission of bacterial diseases is entirely beyond comprehension. Social usage includes insanitary procedures such as spitting on the floor, and forbids various Western procedures such as the use of the handkerchief. Education in common-sense automatic disease prevention is distressingly slow, even in our Western countries, and a bare beginning has not yet been made among the masses of Asia.

One great national habit has undoubtedly preserved the Chinese race from destruction by dysenteries and other water-borne infections such as the typhoids. That is the racial addiction to hot tea. Just as the spout of the teapot

MADRAS PUBLIC LAUNDRY

THE STONES STAND THIS LAUNDRY METHOD QUITE WELL.

was made to drink from, so the boiling water sterilizes the decoction of tea. But all water in lower Asia is infected and even bathing in it is not safe. Up and down the Yangtze, the warm shallow waters carry the cercarial larvae of the Japanese blood-fluke, and these larvae penetrate the skin of the bather or hunter or chance victim. Foreigners thus contract a serious disease at times. Even the mud is full of risk to bare feet because of the omnipresent hookworm.

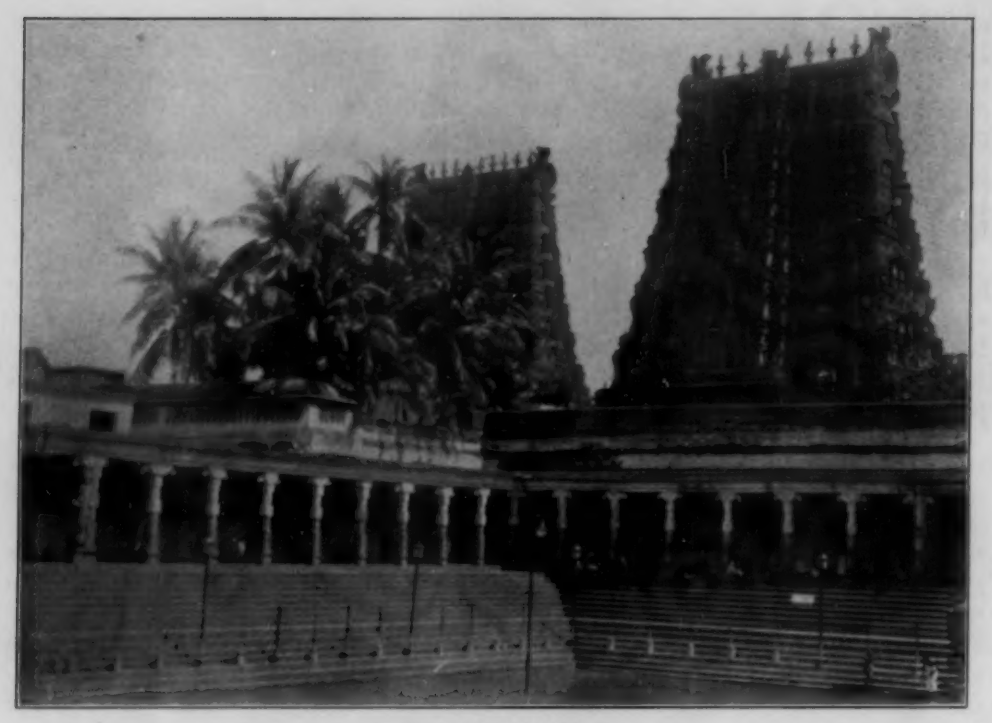
In fact all the helminthic host of human parasites flourish luxuriantly in the fertile soil of China which owes its fertility in chief measure to the use of night-soil as fertilizer. The sights and smells of this traffic beset the landscape and offend the senses in city and country alike. By this means, virulent bacteria and numerous parasites are propagated and broadcast over the land. Not only are the farmers and coolies subject to infection but field produce, vegetables, fruit, melons, etc., are all contaminated and carry contagion to those who eat and drink without care for the morrow. Pineapples and watermelons in southern and central China are a great means of spreading cholera germs. The wily farmer sells his melons and cucumbers accurately by weight, having, however, previously punctured the rinds with stiff bristle brushes and soaked them in water, which is always contaminated. Melons are precarious articles of diet in Asia. And yet the use of night-soil as fertilizer is a logical and economic system. In the West, the most valuable form of fixed nitrogen for plant use is entirely wasted by our wasteful conservancy methods. The Chinese method is effective, saving, logical, but unesthetic and disease-breeding.

In China one must needs pay tribute to two medical institutions at least. One

of these, with great promise for the future, is the entirely Chinese medical school in Shanghai which is a part of the Nationalist Central University at Nanking, the capital. This school is under the direction of Dr. F. C. Yen, an experienced and skilful administrator, highly trained in Western medicine and with a broad patriotism and unselfish honesty all too rare in this great land so sorely in need of leaders. The other is the fine Peking Union Medical College, which represents the statesmanlike policy of the Rockefeller Foundation.

Southward from China one comes into the rich lands of Malaya. The Malay countries center in the Malay Peninsula, one of the richest and perhaps destined to be one of the most permanent of the British colonies. Around this center are the Dutch islands lying between British Malaya and Australia, French Indo-China between Malaya and Hongkong, the Philippines midway between the great fortresses of Singapore and Hongkong, and the fertile plains of Assam and Burma which make Malaya continuous with British India. Only Siam is left, in the Malay group, owing its insularity to the precarious honor of being a buffer state between land-hungry France and imperial England. The carefully systematized exploitation of the Dutch islands and Indo-China rewards the home countries amazingly, and the medical problems of the countryside are handled efficiently by strong foreign rule over a weak and degenerate populace. Batavia has a splendid medical school close knit with the new and excellent Tropical Institute of Amsterdam. Islam and a derived Buddhism largely divide the native races between them. Siam is the very apotheosis of press-agentry and smiles with no forebodings between her two great military neighbors, France and England. In the Malay Peninsula at Kuala Lumpur, a day's journey north from Singapore, we find the Medical Research Institute, unsurpassed in the world for its scientific importance, strategic location and productiveness. Rangoon has its Shwe Dagon, or Golden Pagoda, second only

A NATIVE VILLAGE NEAR MADRAS



THE LILY POOL
HINDU TEMPLE OF MADURA.

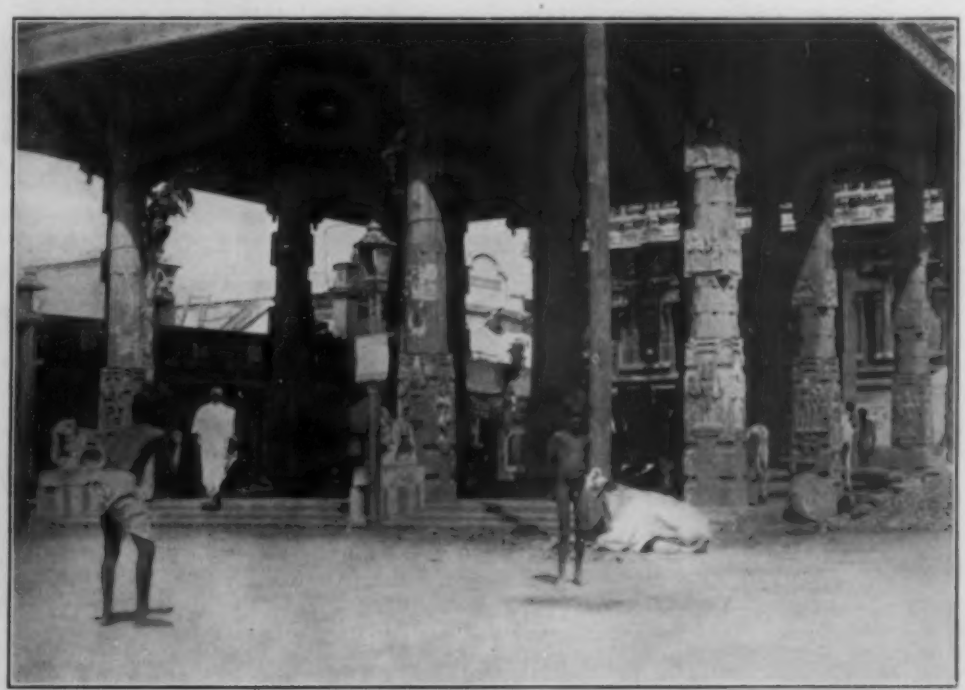
to the Temple of the Tooth in Ceylon in the Buddhist mind for holiness and pilgrimage.

Burma and Assam, even Malaya and parts of India have been cursed with the fever known as kala-azar. This black fever has slain its myriads. But its conquest is even now in progress since medical science has found the cause, the means of transmission and the cure. The causative organism was discovered by Drs. Leishman and Donovan many years ago in India, and after them is named *Leishmania donovani*. Its transmission by sandflies was discovered recently by Napier and his associates at the Calcutta School of Tropical Medicine, and here, too, Sir Leonard Rogers and his successors have established its cure by the intravenous use of tartar emetic. So another great tropical plague has succumbed to the test-tube, the microscope, the guinea-pig and the devotion of medical scientists.

The medical pilgrim must approach India with a fair acquaintance with the history, ethnology and religions of this expansive subcontinent. The story of the East India Company and its unscrupulous mixing of politics, shillings and cannon is just as important as the story of the old native Indian civilization of 1500 B. C. on the southern slopes of the Himalayas. Our medical traveler must know something of the religious pilgrimages of the Orient, of their fanaticism and intolerance of sanitary control, of the hordes who follow them and of the teeming populations from which they come. He must remember that India, which contains Calcutta, the second city of the British Empire in size, is really a land of villages, and that all political, economic and sanitary

measures of necessity are measured to the village unit. He must know of the eighty million Moslems, chiefly in north India, who are bitterly intolerant of the two hundred twenty million Hindus. Of each hundred of the three hundred twenty million inhabitants, sixty-eight are Hindus, twenty-two are Moslems, three are Buddhists, three have tribal religions, one is a Sikh and one is a Christian. Of the remaining two, one is either a Christian or a Buddhist, and the other is probably a Jain, or, less probably, a Parsee, a Jew or a pagan. About 1½ per cent. of the whole population is Christian, and nearly three fifths of these are found in the presidency of Madras (Powell).

The basis of the sanitary sins of India is found in her religions, her poverty and her overpopulation. In fact, the same might be said of the entire Orient. In his readable and reliable book, "The Last Home of Mystery," Colonel E. A. Powell epitomizes the social fabric of the land when he states that the social structure of Hinduism rests on the caste system. The ordinary and oldest classification of castes divides them into the Brahmin or priesthood, the Kshatriyas or nobles and warriors, the Vaisyas, the bourgeois or commercial class, and the Sudras or manual workers. This general idea in fact pervades the Orient, and the Orient has yet to learn the dignity of manual labor and the noxiousness of priestcraft and warriors who parasitize the body of society. The Chinese have corrected the idea by assigning the warrior to the bottom of the list and omitting the priest. But an even more grievous error was achieved because in old China the marks of social culture were found in long finger-nails and corpulence, because these were self-evident separations from physical labor or even exercise. This low valuation of physical exercise and



ENTRANCE TO GREAT HINDU TEMPLE OF MADURA
NOTE SACRED COWS AND PORTICO SUGGESTIVE OF GREECE.

physical development is a sad impediment to personal hygiene in the higher classes of China and, for religious reasons, is an even greater impediment in India.

Returning to the caste system of India, the four chief castes correspond, respectively, to the brain, shoulders, belly and feet of Brahma. There are numberless subcastes, one authority counting 1,429 of them. A quarter of the whole population is represented in the outcastes, such as the Paraiya or pariah, which furnishes all the servants of Europeans.

The religion of Hinduism can best be summarized for our purposes here in the words of two writers. Sir Alfred Lyall said:

> Hinduism is a tangled jungle of disorderly superstitions, ghosts and demons, demigods and deified saints, household gods, tribal gods, local gods, universal gods, with their countless shrines and temples, and the din of their discordant rites, deities who abhor a fly's death and those who still delight in human victims.

HINDU TEMPLE AT MADURA. NOTE PORTICO

A HINDU TEMPLE OF MADURA

Colonel Powell writes:

> Hinduism is the only religion in the modern world that actually wallows and glories in the unnatural, the degrading and the obscene. . . . However wholesome a faith Hinduism may have been in the beginning, however pure and lofty the conduct, thoughts and aspirations of a certain small fraction of its followers, the undeniable fact remains that it constitutes, on the whole, a spiritual cesspool in whose noxious depths every form of depravity and vice flourishes amid the slime. . . . Until it has utterly exterminated these abominations and all lingering belief in them, Hinduism will remain an unmitigated curse to the vast population which it has spiritually enslaved and debauched.

This is the system, deeply sunk in the depravities and perversions of phallicism, which offers so serious a hindrance to health education and the development of a hygienic conscience in India. Only the abomination of the Tantrik religion of Nepal can conceivably be worse. While "Mother

A STREET IN KANDY

India'' does give a partial, distorted and false impression of present-day India, nevertheless the indictment is specific and can not be refuted. ''Uncle Sham'' may endeavor poorly to muck-rake in our own U. S. We recognize truth in that also, but the facts of child marriage, the caste system, the treatment of animals and the but recently abolished suttee can not be gainsaid as types of what Hinduism has brought to the Indian people. Human sacrifice in fertility rites is an institution old as the human race and has been seen the world over, but Hinduism, in its characteristic devilish fashion, debauches a terrible but magnificent allegory to a grossly sensual superstition.

The ten-acre Hindu temple in Madura, far down in the southern tip of India, is a vast congeries of halls, courts, passages, arcades and rooms, most of which are roofed over solidly. Over each of the ten gates rises a truncated pyramid of stone called a gopuram. These are as high as a ten-story building, and each ''story'' is a terrace on which are set thousands of images of the Hindu divinities, depicting their lives and loves, passions, vices, families, servants and all the clustering superstition accumulated in the centuries. Outside each gopuram is a colonnade and portico reminiscent of classical Greece. In and out through these portals stream the floods of pilgrims. The climate is hot, the equator is not far off, the children of the poor are naked, the people are burned black by the torrid heat. Inside is a howling, shouting pandemonium, a jostling, crowding mélange of pilgrims, priests, ascetics, holy men, fakirs, beggars, soothsayers, thieves, panderers, children and aged—all mixed up together with sacred animals and birds. From elephants and camels down to the leprous dogs and sleek rats that scuttle about in the semi-darkness, all is filth, vileness and ob-

BANGKOK WATER MARKET
SIAMESE GIRL WITH BETEL-STAINED MOUTH.

scenity. The myriads of shrines and images divide the worshipers among them. The countless butter lamps sputter and glow in the liquid darkness and coat the images with greasy soot. Doubtless no viler sect of men ever trod this earth than the rabble of the Hindu priesthood. They debauch a race and trade on ignorance and fear in order to make an easy living and perpetuate the evil system of which they are the center. The gross obscenity of the images is exceeded only by the teachings and practices of this filthy herd.

In the center of the temple is the Lily Pool, because every Hindu temple must have its sacred pool or tank for the ceremonial ablutions of the devotees. The Lily Pool in this temple is, as usual, the sink into which seeps the sewage of the surrounding district. Every named disease can probably be found among the wretched dupes who bathe and immerse themselves in its yellow polluted waters. Dead animals decay and disintegrate unnoticed. Living animals are too sacred to be killed, but starvation and disease are acts of fate and not to be interfered with. Each man and beast is living out the result of his actions in previous lives. To change the lot of either, therefore, is to interfere with the just apportionment of the gods. Women can hope for betterment only by being reborn as men. Hence they deserve no consideration, being even lower than the beasts.

These crowded dark temples are prolific sources of disease. Moisture, heat and darkness make them ideal culture beds for bacteria, fungi and animal parasites. Ventilation is present only where the British have been able to force the installation of various make-shift air passages in the roofs. These are the holy places of 220 million people. Their lives are bound up in this system. It colors and controls all they do, think, say and hope for. Only a negligible fraction have any conception of the true meanings underneath. Only a pitiful handful can trace the original philosophy so deeply buried in the spume and vicious chicanery of the superstition, fanaticism and ignorance vomited forth by these temples. Verily it makes

the heart grow sick and the imagination pale to confront face to face such a degradation of human possibilities. Sheer pathos is the sentiment inspired by the sincerity and devotion of these milling millions. All phases of medical interest are touched, and the spiritual and intellectual morass has a direct bearing on the physical and psychological evils here rampant.

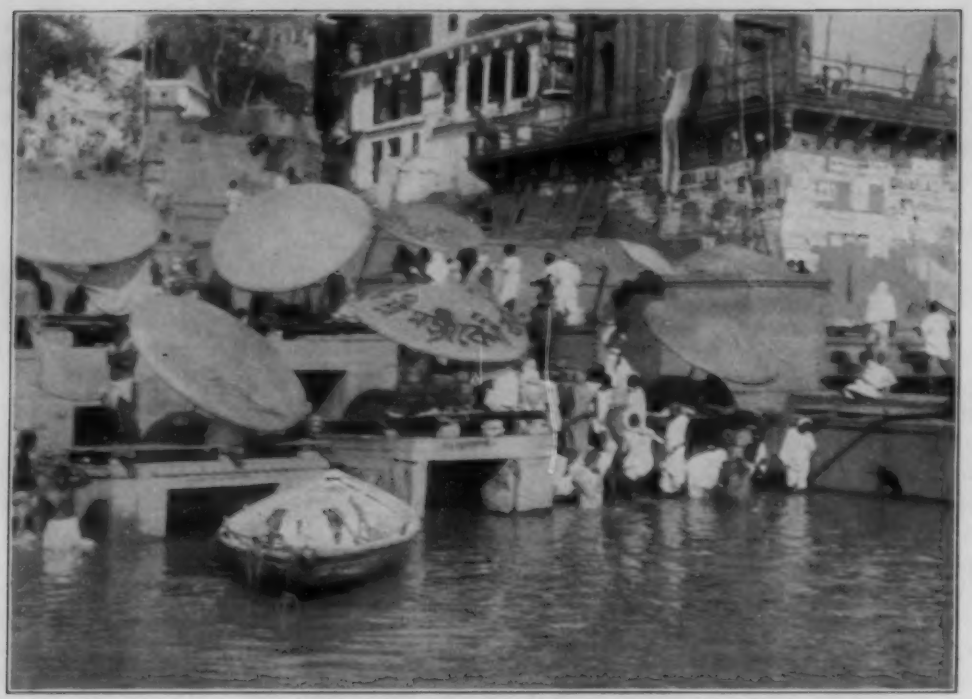
India is too vast, too intricately complex, to be summarized even for medical purposes. A small minority of its people are alive to the needs of the country, are broadly educated, are forward-looking and are unselfishly devoted to improvement. But the predominance is still with the ignorant, fanatical devotees of the great religions of the land. An American can not but be dismayed and chagrined by the number and character of American movies on exhibition. Just as in China and all other Oriental and tropical countries, America is being judged by the trashiest of her cinemas, which are totally misrepresentative and are certain to be highly prejudicial to future international relations, commerce, cultural relations and education. Attention to the character of movie films exported is just as much, if not more needed than attention to immigration and tariff.

At present one does not hear much about drug addiction in India. Opium has been the popular curse of Asia these many centuries. To-day its use is widespread through that continent, but in India opium is overshadowed by another drug group which is a potent cause of mental disease in its devotees. This is the group of drugs derived from Indian hemp. J. E. Dhunjiboy[2] has summarized this subject authoritatively and his data are followed here. The hemp plant was introduced to India from Central Asia as a fiber plant. North of the Himalayas, where it was indigenous, it had presented no narcotic properties, or at least was not used for these. After it was acclimated in India, narcotic properties developed or were discovered, and this led to the first recorded Indian note on the hemp plant in the Atharva Veda. It is now grown and used as a narcotic all over India, and in the Himalayas, Thibet, China and westward through Persia and Syria to Egypt. In cold climates it remains a fiber. In hot climates it becomes a narcotic. It came to India as a fiber. It left India as a narcotic. This exemplifies the common effect of tropical and Oriental residence on human and other immigrants from sterner climates.

Indian hemp (*Cannabis sativa* or *C. indica*) is used in three forms. (*a*) *Ganja* is a mixture of leaves, stems and flowering tops of the female plant. It is smoked in the common water-pipe or hookah, the chilum, the ordinary tobacco pipe and in cigarets. It remains for some follower of the by-paths of human custom to indite a heavy volume on the smoking habits and methods of mankind. Ganja is usually smoked in mixture with tobacco, about three to one. It has an offensive smell and therefore is usually flavored or scented with some one or combination of spices, such as musk, saffron, cloves, cardamoms, rose-leaves or nutmeg. Very often some other powerful drug is added to the mixture, as opium, datura, cocain, nux vomica or aconite. Ganja is also eaten in *pan* (*vide infra*) and sometimes is simply chewed raw.

(*b*) *Bhang* (siddhi, subji or putti) consists of a mixture of the dried leaves and capsules of both male and female plants. It is used as a decoction, as we use coffee, and is the weakest and cheapest of the three drug forms of hemp. The word Bhang refers both to the crude drug and the decoction, or "tea." "Every drinker who can afford it adds

[2] Transac. VII Congress of Far Eastern Assoc. of Trop. Med., 1927, Vol. I, page 400.



BATHING GHAT AT BENARES

some of the following—anise, fennel, coriander, dill, almonds, rose water, cloves, saffron or cardamom. Also, as with ganja, other strong drugs may be added, even opium and arsenic. Bhang is eaten in molasses and in *pan*. Many sweetmeats contain bhang, especially in Majum, which consists of sugar, milk, bhang, and possibly also ganja or charas."

(*c*) *Charas* is the resin exuding from the flowering heads of the female hemp. It is smoked or eaten. It is more powerful, more concentrated and more expensive, which limits its use to the wealthy. This is the hashish of Arabia.

It is a social custom to offer bhang to members of the family and guests on festive occasions, and its use somewhat corresponds to tea-drinking in China and Japan. Ganja is reputed to have been in favorite use by Siva. Hindu priests and people use it in the worship of Siva. Better far if the fiber had been so associated rather than the narcotic! The Sikhs are especially addicted to bhang, and use it in ceremonials on the authority of the Sikh scriptures, the Granth. Charas has no religious associations. Mohammedanism condemns the use of all drugs as well as of alcohol, both prohibitions being widely honored in the breach. In the year 1925–26, the Bengal presidency alone derived a revenue of 48½ lakhs or nearly $2,000,000 from the excise duties on these drugs.

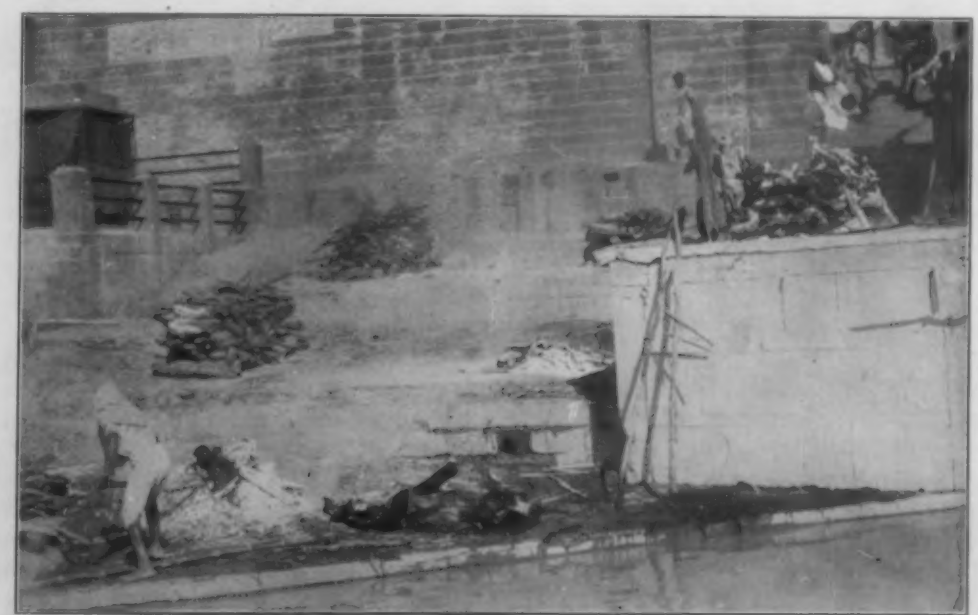
The active principles of hemp are most abundant in charas and least in bhang, but the actual substances have not yet been isolated. In Orientals, a moderate dose causes an intoxication going on to complete drunkenness. A dreamy state with exaggerated flight of ideas often of a sexual nature ends in deep sleep. Some users go through a highly stimulated psychic phase before sleep intervenes. "A large dose causes excitement, delusions, hallucinations, rapid flow of

ideas, ecstasy, psychomotor activity with tendency to wilful damage and violence. This is followed by deep sleep and forgetfulness of all but the initial stages. This temporary amnesia is very important from a medico-legal point of view. The duration of actual amnesia is difficult to judge."

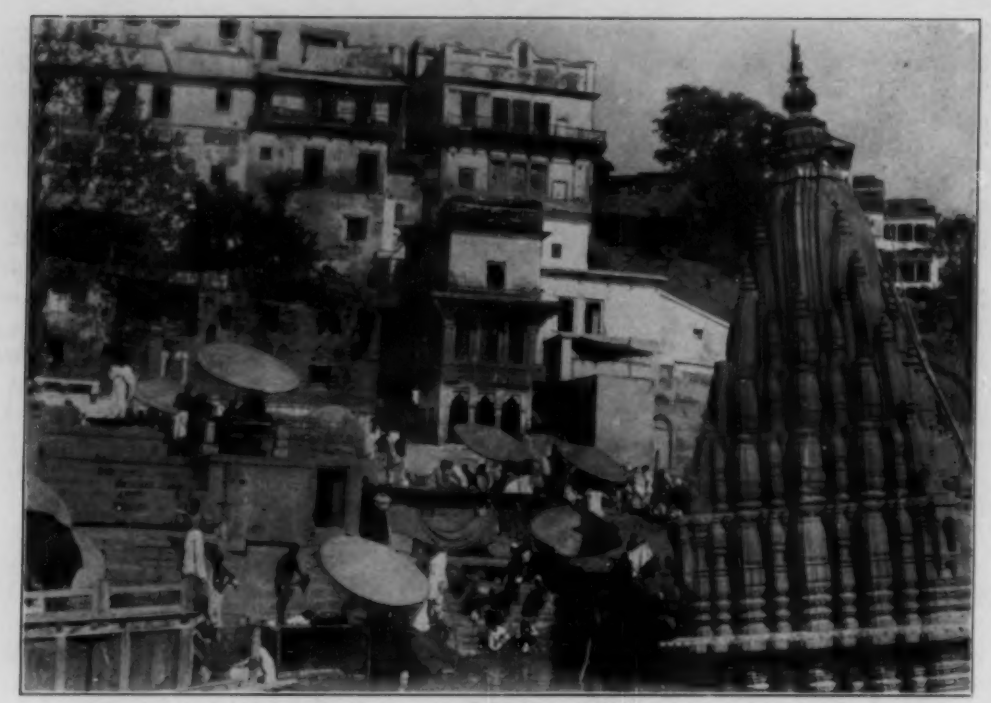
In the fourteenth century in Egypt, Makrizi stated that in year 78 of the Hegira severe laws were passed in Egypt against the use of hemp drugs. Violation was punished by pulling the teeth. In year 799 of the Hegira, hemp addiction was more firmly established than ever. Use of these drugs in any form in large quantities may result in an acute delirious mania which is characterized medically by lack of hereditary influence, by acts of great violence and by a characteristic devil-may-care demeanor. This may go over into a chronic mania where these symptoms are milder, loss of speech for long periods may occur and where the sense of well-being, or euphoria, is prominent. A peculiar congestion of horizontal vessels in the eye (conjunctiva) is diagnostic. A third form of hemp insanity is a dementia. It is peculiar that there are no abstinence symptoms on stopping the drug at any stage and treatment consists simply of drug interdiction.

The hemp drugs strongly predispose to crime. Criminals fortify themselves in this manner, and especially add datura to the hemp. This is at least one cause of "running amok," a violent and dangerous acute insanity common in Malay countries. Hemp drug addiction is more important in India than alcoholism, opium or cocain as a cause of insanity. Hemp is to India what alcohol is to the Occident.

Everywhere in southern Asia is seen the scarlet mouth and spittle of the betel-nut chewer. It is estimated that a tenth of the human race are betel chewers. The name "betel" is used for two different plants. The first is the areca, or betel, palm (*Areca catechu*), a slender, graceful palm reaching a height of forty to fifty feet with a cluster of fan-like leaves at the top. At the origin of



BURNING GHAT AT BENARES



BENARES BATHING GHATS

NOTE TEMPLE SINKING IN MUD, AND UMBRELLAS OF THE BRAHMANS.

these leaves grow the nuts, the size of a hen's egg, looking somewhat like mammoth nutmegs. Inside the tough rind the hard nut is nicely mottled in brown and gray, and is sometimes used for small ornaments and buttons. For chewing purposes, they are picked just before ripening, are husked, boiled in water and shaved into thin slices which are dried and blackened in the sun. These thin slices are rolled in a succulent leaf of the second betel plant, the betel vine or *pan* (*Chavica betel*), which is a cousin of the black pepper plant. With the betel-nut are mixed a little freshly slaked lime, called chunam, and various spices, as in the case of ganja. A copious flow of scarlet saliva results. Apparently cancer of the mouth is somewhat more common in betel chewers. In addition many use zarda, which is an aromatic preparation of tobacco. The use of pan and zarda together destroys the taste so the user may go days without food.

Pan, or tambul, has been used from ancient times from Africa to the Philippines as a digestant, stimulant, aromatic and aphrodisiac. Betel-nut is reputed to be a vermifuge and is the source of the alkaloid arecolin, widely used in veterinary medicine as a worm remover in canines. The betel-nut is also called supari. The native belief is that it hardens the gums, sweetens the breath and increases saliva. It is taken first to cure disease, then to prevent disease and finally as a habit. It is offered to guests as a carminative before and after eating, much as Occidentals proffer mints. Thus with the Hindus and somewhat less with the Moslems, it has become a form of courtesy. All natives use it as an aphrodisiac, and Indian literature, both sacred and profane, has extended commentaries on this usage. S. J. Modi has

shown that the betel chewer suffers definite ill results in loss of sensitiveness of the gums, attrition of the teeth by constant chewing of tough fiber, excessive tartar deposit, recession of gums, pyorrhea and loosening of the teeth. Dental decay is decreased.

The usual Indian toothbrush, ceremonially required in the case of Hindus, consists of a twig of *Acacia arabica*, the so-called baval stick. This was prescribed in the Ayur-Veda. Other prescribed twigs are used to less extent as, for instance, from the banyan (*Ficus indica*), the Karanja or Indian beech, the neem or margova tree and the pippala or peepul tree. Something must be said for the cleanliness and cheapness of this type of toothbrush. These twigs must be chewed from ten to twenty minutes to form a coarse "brush" at one end. The chewing and coarse fibers packed between the teeth cause damage to the gums and much attrition of the teeth. The Brahman must abstain from washing his teeth on the sixth, eighth, ninth, eleventh, fourteenth and last day of the moon, on the days of new and full moon, on all Tuesdays, on the day of the constellation under which he was born, on the day of the week and of the month which correspond with those of his birth, at an eclipse, at the conjunction of the planets, at the equinoxes, the solstices and other unlucky epochs and also on the anniversary of the death of his father or mother. Such is the life of a Brahman. Certainly tooth-brushing will not burden him, even though he is allowed to substitute grass or leaves for the ceremonial twig on the forbidden days.

THE GHATS AND RIVERSIDE AT BENARES

A FESTIVAL IN A BOMBAY BAZAAR

Few places on the earth are more important than the Ganges River as centers from which epidemics spread. This is due, in the first place, to local conditions which lead to heavy infection of the river and the crowded cities on its banks. In the second place, millions of Hindus visit these localities on pilgrimage and carry contagion back with them broadcast over the country. The sanitary control of pilgrimages is one of the most difficult and delicate problems in the Orient. Crowded, insanitary quarters

TRAFFIC COP ON A BUSY BAGDAD CORNER

for pilgrims, ceremonial bathing and carriage of sacred water back to the villages cause untold disease and death. Similar to this is the situation arising from the desire of all Hindus to be cremated on the banks of the sacred Ganges. As a result, bodies dead of dangerous diseases may be carried for journeys of many days under the hot sun of north India.

The holiness of the Ganges River is concentrated to a superexcellent degree at Benares. This city of 300,000 people may have twice its own population of pilgrims coming and going at once. Its thousand Hindu temples do not have sacred tanks individually but the river is used by all. The pilgrim performs specified rites and ceremonial ablutions in the river before visiting each temple and also as an object of pilgrimage itself. The howling din of the temples with their filthy mud, diseased animals and wild-eyed devotees is more than matched by the crowded ghats of the Holy Mother Gunga, the sacred sewer of the Gangetic plain, which rolls its yellow flood slowly down to the myriad mouths where it joins the Brahmapootra in the Gulf of Bengal.

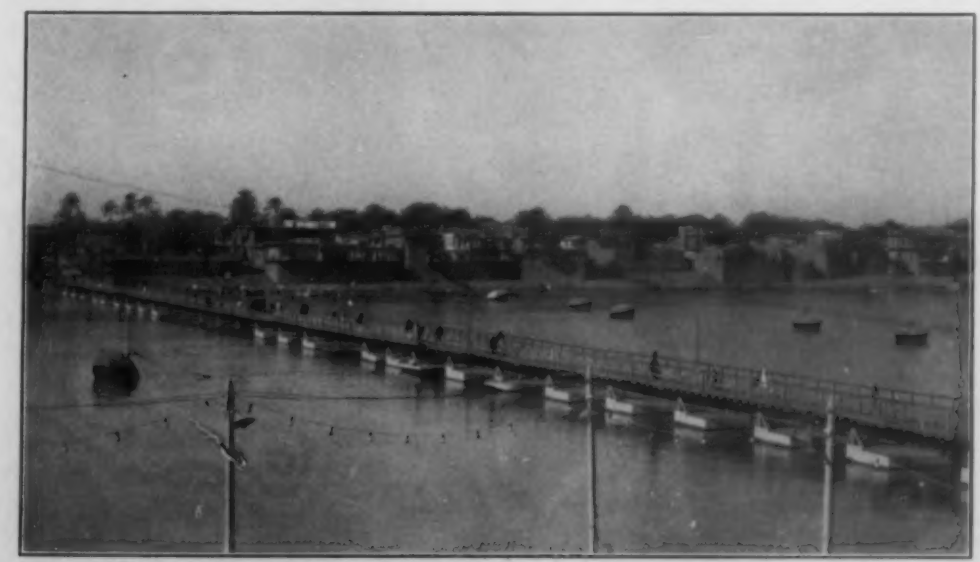
The stone steps, or ghats, leading down the steep river banks are a never-ending panorama of human misery, hope, devotion, fanaticism and gross superstition. Brahmans sit smugly under their wide umbrellas of split bamboo and for a price recite mantrams and prayers and repeat stories from the sacred literature. In the water are crowded the bathers, immersing themselves, washing their mouths, drinking, putting water in eyes, ears and nose, and following the complicated rituals of their faith. Among them the supercilious Moslems are doing their family laundry and bathing for the purpose of "cleanliness." Small children swim, duck and dive among them with many shouts.

The river itself carries along the sewage, dead animals, charred fragments of corpses and general accumulations of a crowded tropical plain. Crocodiles are rarely seen now, possibly having died from overeating. Buildings, temples and palaces are slowly sinking in the alluvial mud and new structures are constantly rising on their disappearing roofs. The maharajas of the native states, 45 per cent. of all India, have their palaces here, to which they will come to spend their last days in the thick odor of sanctity, to be burned on the burning ghats and have their ashes scattered over the broad bosom of Mother Gunga.

A greater contrast can hardly be imagined than to take the overnight journey from Benares down to Calcutta and visit that glory of medical science, the Calcutta School of Tropical Medicine, a splendid, large research building, facing a research hospital of 200 beds. On the same square is the great municipal hospital. An outstanding group of physicians and scientists is gathered here, men whose names carry authority and are known far beyond India. Colonel Acton, the director, Drs. Napier, Knowles, Muir, Chopra, Strickland, with their associates, would make any institution famous. Incidentally, it is interesting to see here in operation a principle destined for wide application in the tropics—refrigeration of rooms and houses comparable to heating of the same in cold climates. Rooms and suites with reduced atmospheric pressure and with controlled cool temperature will be important adjuncts in the treatment of disease in the tropics.

The Calcutta School of Tropical Medicine and Hygiene is a living monument to the faith, ability and persistence of its founder, Sir Leonard Rogers, who has now retired from the Indian Medical Service and is located in London. It was built and is maintained by moneys contributed by planters, shippers and other business men of India with subsidizing aid from government. The business community had found by hard and costly experience that commerce could not be developed or be successful without the aid of scientific medicine. That lesson needs to be learned in these United States.

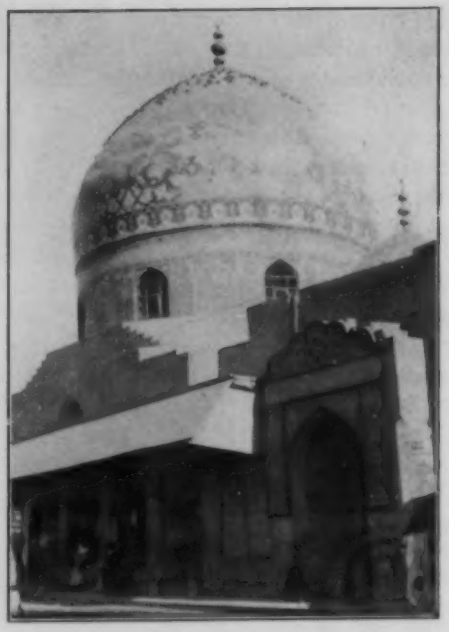
American commerce can not even ex-



MAUDE PONTOON BRIDGE OVER THE TIGRIS AT BAGDAD

ist, in the conditions of competition now developing, unless it utilizes medical science in connection with its marine transport and foreign contacts. American commerce needs several first-class institutes of tropical medicine. It needs them especially in San Francisco, New York and New Orleans, where sailors and shipping are concentrated. France, Italy, Germany, Holland and England know this fact full well, and each of them has institutes of tropical medicine, working hand-in-hand with commerce and government. Hamburg city, the great port of Germany, maintains the finest tropical institution on the continent as part of its city budget. American commerce can well take counsel and warning from these other countries or its path will be costly, difficult and even impossible.

The medical traveler can not but be impressed by several striking facts in the leprosy situation of the world. Once known chiefly in cold and temperate climates, leprosy is now primarily a tropical disease and in some places almost epidemic. Two great facts stand out. One is the hopeful outlook for arrest or even cure of the disease with modern methods of treatment. The other is the change in sentiment with reference to quarantine and isolation. Treatment is potent in proportion to the earliness of its employment. Segregation has always meant that chiefly advanced cases and only a percentage of these would be discovered. Sir Leonard Rogers and Dr. Muir, of Calcutta, have stood strongly for a reversal of this policy, establishing ambulatory treatment stations thickly, registering all lepers, spreading healthy information about the disease and as quickly as possible making patients non-contagious. Only dangerous contagious cases are isolated, and then only until rendered non-contagious by treatment. The result is that lepers flock in for treatment in the earliest stages when treatment is most effective. Moreover, they are not withdrawn from industry to be maintained at the expense of government or charity, but remain self-supporting, in hope and usefulness, instead of being immured in the horrible living death of the earlier leprosaria. The work of Muir and



THE LARGEST MOSQUE IN BAGDAD

A DESERT STATION ON THE RAILROAD FROM BAGDAD TO BASRA. BEDOUIN WOMAN AND BOY.

BASRA DOCK SCENE

ARAB FAMILIES WAITING TO BOARD THE STEAMER.

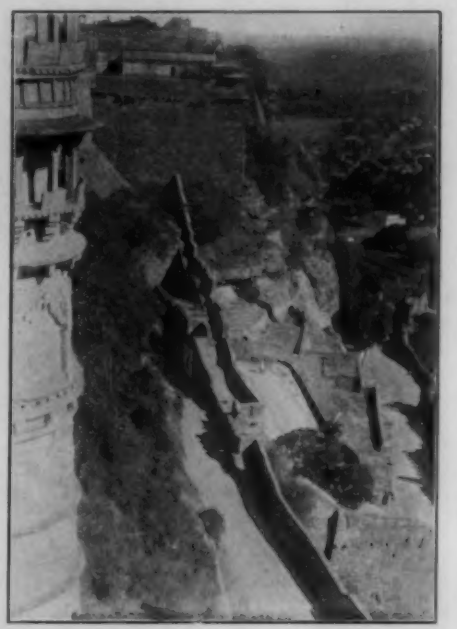
Rogers in Calcutta is noteworthy as is also that of Dr. H. W. Wade and his associates at the great leprosy station of Culion in the Philippines. This latter has now been endowed as the Leonard Wood Memorial, and is a monument indeed to American tropical medicine.

One hardly thinks of India without the mind turning to the subject of snakes. The cobra is closely interwoven with the legend, history and religion of the Hindus. It is sacrosanct, even above other animals, and must not be killed, in fact, is to be worshiped as the sacred Naga. The serpent-lore of India is completely detailed in an erudite volume under this title by Dr. J. P. Vogel. From Egypt to China, the snake has an allegorical usefulness that embodies man's instinctive fear. The ancient ruins of Angkor have the Buddha-like colossi holding the great body of a sacred Naga rearing its seven-headed crest a hundred yards from the narrow, tall elephant gates where the four faces of Siva look down with immemorial and inscrutable calm. In India itself the small true vipers, like the krait, are exceedingly deadly. The cobra family is omnipresent. And in the warm waters of the Indian Ocean and Persian Gulf, the sea-passenger sees multitudes of the brilliant, transversely colored coral snakes, three to four feet in length, like true sea-serpents riding the waves. These snakes never go ashore. They are viviparous and breed at sea. Their bite is deadly, but swimmers are rarely bitten. Water temperatures over 90° F., abundance of sea-food and few enemies make life pleasant for them.

It is probable that half or more of the deaths from snake-bite, in India as well as elsewhere, are due to fright or injudicious treatment. Treatment by tourniquets, free bleeding and the appro-

priate anti-venin is best, and alcohol is an invariable danger. Snakes are deaf and nocturnal. They easily perceive vibration, however. Hence a person walking noisily in leather shoes usually gives enough notice of approach to warn the reptile, which slinks away. Cobras do not flee so readily as other varieties and have even been known to attack without provocation. Walking at dusk or after dark with a lantern and well-booted is the best protection. Usually it is the barefoot native with silent footfall and no light who startles the snake and gets bitten.

The major evils of India, in comparison with Europe, lie in the lower population increase in the face of a higher birth-rate, and a smaller fecundity in spite of a larger proportion of married persons. The population seems to be near the saturation point. The life expectancy is low and sinking lower.



ELEPHANT ROAD UP GWALIOR HILL

PRIMITIVE WELL OF SOUTH INDIA IN COCONUT GROVE

NOTE TWO MEN TWENTY FEET ABOVE THE GROUND WORKING THE WELL-SWEEP.

There is a high death-rate among young mothers. As everywhere, the population increase is higher in the lower classes. Poverty breeds children but can not raise them. As Adam Smith said, "Poverty seems even to be favorable to generation. But poverty, though it does not prevent the generation, is extremely unfavorable to the rearing of children." Artificial limitation of birth-rate is always a debatable expedient, but the same result can be obtained by improvement in economic status and in education. At present, instead of these natural and automatic curbs, India, like China, has war, famine and disease.

All over tropical Asia the experienced traveler carries with him a well-constructed mosquito net, because in many places no net is provided, as in Siam because of local pride, which says there are no mosquitoes of consequence to be feared. A stout flash-light is also valuable, for searching out hiding insects and for various night alarms. Fresh

salads in all Oriental and tropical lands are anathema, and one quickly learns to eat only freshly cooked food. A clean kitchen in charge of a clean cook is rarely found, and simple table precautions save much danger. Various vitamin-deficiency diseases are seen universally, such as different forms of beriberi, pellagra and also the peculiar condition called sprue. Sprue was formerly widespread in Ceylon. Now it is rarely seen there. At the same time deficiency diseases in cattle have decreased along with more intelligent feeding methods, and the foreign human population has changed its dietary habits to include more fresh native foods and less imported canned articles.

The question of sunstroke, heat-exhaustion or heat disease is of perennial interest. The researches of Dr. Sundstroem at the University of California are opening the way to a much-needed improvement in our understanding of the influence of barometric pressure, temperature, moisture, ventilation and incidence and character of solar radiation. It is probable that the state of one's liver has most to do with the onset of heat disease. Malaria and other infections are easily lighted up. Heat exhaustion is a form of heart failure, induced by climatic conditions in a person predisposed by cardiac weakness or liver congestion.

The tropical world in general has two kinds of climate. One is the moist heat of the equatorial zone, with a maximum of rainfall and cloudiness at the extreme. The other is the dry hot desert zone which borders the wet tropics both north and south of the equator. We see this latter exemplified in the dry plateau regions of our own Southwest and in central Mexico. The same belt in Iraq and Arabia presents many interesting medical situations. Mesopotamia is still a country to swear not only *by* but *at*. Its three million inhabitants are primarily desert dwellers.

From Basra and waystations on the Shatt-el-Arab or mouth of the twin rivers is shipped the bulk of the world's date supply. Here two green strips bordering the rivers are the original home of the date-palm. Over 110 varieties and eighty million trees yield their sticky sweetness to the Arab gatherers, who stamp them bare-footed into burlap sacks, along with flies, vermin, perspiration, excreta, dust and all sorts of just plain dirt. Having seen the date culture in practice, the traveler will carefully restrict his home supply to a product guaranteed to have been produced and packed in southern California.

The old Turkish hospital of Bagdad was taken over by the British and made into an up-to-date and thoroughly efficient modern general hospital. The Turks kept as patients only those who were able to work. The others died or were thrown out. The result was unfortunate medically but has left for the present administration wonderful grounds and gardens with a profusion of trees, shrubs and flowers. Even a small medical school is being started in the effort to train native practitioners to carry the leaven of Western medicine to the tribesmen. Drs. Dunlop, Sinderson, Mills and their associates are working out a fascinating medical program in the old city of the califs. A visit to the Royal Hospital of Bagdad will repay and stimulate any visitor.

The bazaars of Bagdad, Mosul, Aleppo and Damascus are replete with interest for the medical eye. For four thousand years Damascus has been an inhabited city. It has always been the trade center of the desert, and its history is the story of ancient civilizations. Its native medical practice has been little affected by Western science, but Syria boasts of the best medical school in the Near East in the American University of Beirut. Likewise in Syria and Palestine the

LABORATORY TENT

IN TREATMENT STATION IN VILLAGE OF LOWER EGYPT.

places and tales of crusader renown have a singular appeal for the medical wayfarer. The story of the Knights Hospitallers, of the Knights Templars and the Orders of St. John and Jerusalem and Malta bring a wonderful record of medical care and nursing service. The present-day activities of the Hebrew University on Mt. Scopus overlooking Jerusalem, the conquest of malaria in Jerusalem, the control of animal diseases and many another work of health and sanitation need more than the present space even for a catalogue.

The Arabs had an old prophecy that when the waters of the Nile flowed in the streets of Jerusalem and a son of the prophet entered through the Jaffa Gate, then would the Golden City be lost to the power of the Turk, and it so happened that Allenby, the British conqueror, entered the city walking through the Jaffa Gate, and his name in Arabic was "son of the prophet." Also it happened that the British Tommies brought with them in a pipeline, up across the desert from Kantara on the Suez Canal, the sweet waters of the Nile, and they ran in the streets of Jerusalem.

Those waters of the Nile, for thousands of years, have carried fertility to a little band of greenery along the Desert River, spreading out in the great triangle of the delta, to water a land and make its people great because of their independence of weather and seasons. The granaries were sure. The river always came in flood. Great Egypt was in this respect different from the rest of the Sahara. But something else came with the life-giving water and sucked away the greatness of the people. Two lowly parasitic worms destroyed the grandeur of ancient Egypt and have held it in subjection even to this day. The hookworm is one of these, and the other is a schistosome worm, named after Dr. Bilharz, who discovered it in

1851. Modern scientific medicine has found the specific for each of these parasites. The hookworm has yielded to the strategic campaign of the American Rockefeller Foundation. Within the past few years Bilharzia has been cured by injection into the veins of solutions of tartar emetic. The Egyptian national board of health maintains fifty-two treatment stations for these two worm infections, the system centering in the laboratories and municipal hospital of Cairo. This century-old hospital, the Kasr el Aini, is being rebuilt on an island in the Nile. Thus modern medicine is restoring to Egypt what two minute worms took away, and the future only can see the result.

It is impossible to finish even these sketchy remarks on medical by-paths in the Orient without reverting to the two propositions with which we began. Religion and race are one. The rising tide of nationalism is irrepressible and must receive due reckoning. In our nearer Pacific Ocean, China stands out as the strong nation of the future. Geographically the Philippines belong to China. The eleven million Chinese outside China control a surprising share of the business of the Orient from Japan through Calcutta. Chinese by demonstration are capable of penetrating, controlling and governing the Philippines. Some day they may do so.

Three points at once become important. (1) For the good of the Philippines and the peace of the Orient, which is the peace of the world, the United States should govern the Philippines permanently on a colonial, dominion or territorial basis as may be determined. Withdrawal of the United States means leaving unprotected this enormous archipelago, bound by many ties to China, coveted by Japan, yet faced by the military power of France four hundred miles distant, and lying between the

CALIUB, LOWER EGYPT

GROUP OF PATIENTS AWAITING TREATMENT.

powerful jaws of the British lion in Hongkong and Singapore. (2) The United States must, of necessity, willing or not, face in the future a unified and powerful China. Discriminatory exclusion in the Philippines can not be enforced to-day and will not be tolerated either in the Philippines or the United States in another generation. Good judgment, justice and even self-interest unite with plain necessity in dictating that the United States guarantee fair play to China with reference to other great powers and that the United States cultivate the friendship of China in the strong relations of mutual acquaintance, assistance, forbearance and understanding. (3) One of the most powerful means of cementing international friendship and understanding is found in scientific institutions of broad and international scope and usefulness. Community of education and scientific study lead to friendly commercial and social relations. Such is the function of the Pacific Institute of Tropical Medicine being established in the University of California in San Francisco. The eyes of America are still turned westward. Trade must, more than ever, be built on acquaintance and personal friendship. The markets of the Orient are tremendous and competition for them is keen. Surely here we have a sound and logical common meeting-ground. Surely international good-will around the Pacific basin can be fostered in no more practical way.

COSMIC CLOUDS

By Dr. HARLAN T. STETSON
PERKINS OBSERVATORY, OHIO WESLEYAN UNIVERSITY

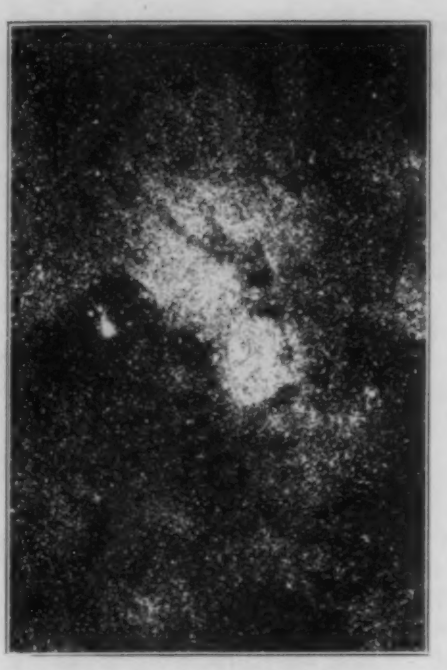
On the following page is a photograph of one of the conspicuously dark regions in the Milky Way. When Sir William Herschel first picked up one such region with his telescope and was aware of the sparsity of stars within it, he is said to have exclaimed, "Mein Gott, da ist ein Loch im Himmel!" (My God, there is a hole in the sky). In these apparently empty spaces Herschel believed he was looking out through our universe into the vacant recesses of space, far, far beyond the stars.

When Barnard, at the Yerkes Observatory a little more than a decade ago, was making his photographs of the Milky Way, he discovered a great many such dark regions. The more he studied his photographs the more firmly he became convinced that these dark regions in many cases were to be interpreted not as vacant spots devoid of stars but rather as dark patches of obscuring matter cutting off completely the light of the luminous stars beyond. It was the old problem of relativity again. This time it was not a question of relativity of motion, but a question of the relativity of background. Considerable skepticism prevailed at the promulgation of this heretical view-point. However, Barnard persisted in maintaining his interpretation and carried on with his photographic program. His accumulating photographic plates probably did more than anything he wrote about them to build up confidence in his newly propounded theory.

To-day the existence of large obscuring masses in the Milky Way and the existence of dark matter bordering many diffuse luminous nebulae is scarcely doubted. Other galaxies, such as the great nebula in Andromeda, reveal vast stretches of dark matter entangled in their spiral whirls, engulfing stars and obstructing them. Is it possible that in our own stellar universe our sun may now be in the midst of some such cloud, or can we be assured that while many other suns may be embedded in such murkiness our own is quite immune and we look skyward from our earth with the confidence that we see the stars through uncluttered space? This is a most vital question, for many of our estimates of distance to the remoter objects of our universe depend upon the assurance that light from those distant regions does not suffer diminution through traversing such enormous distances.

Many experiments have been made bearing on the problem. If the hypothetical ether which bears the light waves were a material homogeneous substance like water or air, then it should absorb some of the light traversing it. In consequence, like water or air, it should slightly disperse the light in accordance with its wave length. Blue light, therefore, should travel somewhat faster than red or yellow as it comes to us from a distant star. Fortunately this is easily tested by photographing the variations in the brightness of well-known variable stars in blue and yellow light simultaneously. Results show that there is no perceptible difference in the times of arrival of the blue and yellow light, even over extraordinary distances. Thus we may safely dismiss the question of absorption of light by the ether as more imaginary than real, a phrase probably quite as applicable to the ether itself.

DARK AND BRIGHT NEBULOUS MATTER IN THE VICINITY OF RHO OPHIUCHI



THE BLACK HOLE IN SAGITTARIUS

The question of the dimming of the distant stars by particles of dark obscuring matter is an entirely different affair. The obscuring power of a given amount (mass) of material varies greatly with the size of the particles of which it is composed. The smaller the particles, down to a certain limit, the greater will be the obscuring power, the maximum occurring when the finely divided particles are about a hundred thousandth of an inch in diameter or of the order of the wave-length of visible light. Thereafter as the particles become smaller they rapidly lose their power of stopping light. An astonishingly small amount of finely divided dust, such as smoke, for example, can produce a vast amount of dimming. Russell points out that a layer of dust containing only a tenth of a milligram for each square centimeter would be completely opaque no matter what its thickness, and on this basis the whole vast obscuring cloud in the constellation of Ophiuchus could be produced by a quantity of matter equal to hardly more than the amount of matter contained in a dozen of our suns. Of course if the solar system were now in any such cloud we should see no stars at all. The fact that our vision of the universe is as good as it is indicates that the sun's immediate neighborhood is reasonably transparent. On the other hand, there is evidence that space about us is not empty. The number of meteors falling to the earth is an indication of some of the larger lumps of cosmic material which abound in space and have presumably been captured by the solar system. It seems likely that a vast amount of such material from huge masses weighing tons down to the finest dust particles and gas molecules must be roaming at large in space until encountered and brought into local control by some passing star or planetary system. The existence of such cosmic clouds in the neighborhood of other stars gives rise to a certain amount of visible nebulosity where the light by which we photograph it appears to be reflected or excited from the nearby stars. A notable example of such a situation is to be found in the Pleiades.

Solar Corona

If the solar system were in the edge of such a cloud, however tenuous, we

NCC 4594 NEBULA SHOWING DARK ABSORBING MATTER

NEBULOSITY ABOUT THE PLEIADES
PROBABLY ILLUMINATED BY EXCITED RADIATION FROM THE NEIGHBORING STARS.

should expect to see some of it illuminated in the immediate vicinity of the sun whenever the direct sunlight was obscured, as in the case of a solar eclipse. It seems reasonable to suppose that we may account for a large part of the coronal illumination in this way, especially as regards the outer corona. In place of the structural details of the corona being produced by the particular way in which matter is thrown out from the sun, we should have in this hypothesis the material particles already existing about the sun, and their visibility brought about by the streaming of electrons along paths more or less definitely defined by the sun's electric and magnetic fields. The tendency of the streamers when present to group themselves somewhat symmetrically about the magnetic pole of the sun is consistent with such an interpretation. The form of the corona would not only be quite dependent upon the degree of solar activity, which varies with the sun-spot cycle, but at the same time would be influenced by the general density and distribution of the surrounding particles.

Zodiacal Light

Shortly after sunset and as soon as twilight has vanished there is visible in the tropics a conspicuous glow of diffused light extending upward from the sunset point sometimes all the way to the zenith. At its greatest breadth it subtends an angle of thirty to forty degrees. It is the zodiacal light. It may be seen in northern latitudes in the spring of the year after sunset or in the autumn before sunrise, although in neither case so conspicuously as in the tropics where its axis is more favorably situated with respect to the horizon. The usual explanation which has been offered for the phenomenon is that it is the reflection of sunlight from small meteoric particles circulating about the sun. It is appropriate to note that this phenomenon adds considerable support to the hypothesis of a circumsolar cloud.

Our observations of the zodiacal light made in the Indian Ocean on return from the Malaya eclipse of May 9,

THE SOLAR CORONA OF THE ECLIPSE OF 1926
(*Swarthmore Expedition*)
THE ILLUMINATION SUGGESTS EXCITATION OF A CIRCUMSOLAR COSMIC CLOUD BY EMITTED SOLAR RADIATION.

1929, revealed unmistakable fluctuations in its brightness over a period of two or three minutes. The literature of the subject reveals that similar fluctuations have been observed from time to time by other observers, notably by Chaplain George Jones, U. S. N., in 1854. The rapidity of the fluctuations suggests that we may be dealing with a neighboring material in cosmic cloud, excited by solar activity. Perhaps it is not without significance that the fluctuations observed in 1929 were concomitant with solar activity, as indeed is the general appearance of the corona itself. It might be added that on the day in question, May 31, 1929, when the fluctuations in brightness were most conspicuous, a naked-eye sun-spot was nearly centered on the solar disk.

A somewhat associated phenomenon is that of the *Gegenschein* or counterglow. This is a faint patch of light rather definitely circular in shape which may be seen under extremely favorable conditions at that point in the sky directly opposite the sun. The light is but a little more intense than that of the general sky illumination. It has been suggested that this, too, is the reflection of sunlight from small meteoric bodies at a considerable distance from the earth. In the theory of celestial mechanics there are dynamical grounds for suggesting this point as a rendezvous of meteoric material circulating about in the solar system. On the hypothesis of a spatial dust cloud it might be possible to account for such a patch of illumination as due to sunlight refracted into the earth's shadow by the shell of its atmosphere. The refraction of sunlight passing tangentially through the earth's atmosphere amounts to half a degree and would produce a luminous cone coming to a focus in space at a point 450,000 miles back of the earth. For a considerable distance inside this point a cloud of particles might be sufficiently illuminated to produce the observed effect.

Comets

Possibly a further argument for the existence of a circumsolar cloud is to be found in the behavior of comets' tails. It is common knowledge in astronomy that the tails of comets inevitably stream in a direction away from the sun. It has generally been supposed that all the material in the tail of a comet has been ejected from the head and borne away from the sun by the repulsive force of solar radiation. There is some difficulty, however, on such a hypothesis, in accounting for the radical shift in the direction of a comet's tail as it rounds the sun. In some instances where the comet passes the sun at a close range the tail must whiff about through one hundred and eighty degrees in the space of a few hours. For material particles to be emitted from the head at a rate to resupply a tail a hundred million miles long, under such circumstances, demands almost unthinkable velocities. On the other hand, if we suppose the general illumination of the tail to be produced from the excitation of a cosmic cloud of dust and gas by streaming electrons from the comet's head, the change in the direction of the tail illumination will take place with the speed of electronic emission, even comparable with that of light. Moreover, sudden changes in the illumination and form of the tail are often observed, notably in the case of Morehouse's comet in 1908, which, very difficult to explain on the basis of the light-pressure theory, appear plausible on the new hypothesis. The fact that faint stars have appeared undimmed by the tails of comets appears to be no surprise on the supposition that the bulk of the material composing the tail was already there in space. The stars would shine through it equally well whether it was illuminated or not. In any event the density of the material must on the

average be very low. Calculations in the case of Halley's comet have shown that *on the average* the amount of stuff in two thousand cubic miles of the tail was not greater than that in a single cubic inch of ordinary air. However, this does not preclude the existence of lumps of matter of considerable density widely scattered through space. Barnard, in studying his many photographs of comets, often spoke of sudden changes in the appearance of the tails suggesting encounters with a "resisting medium." Such abrupt changes might well occur on those relatively rare occasions when a comet would pass into some local aggregation of cosmic cloud in the vicinity of the sun.

Dimming of Stars

If the solar system now were in the midst of a cosmic cloud of indefinite extent, then of course the stars would appear increasingly fainter than they should with increasing distance from the earth. Such does not appear to be the case. If, on the other hand, we suppose our cloud to be more or less a local affair extending perhaps not more than a hundred light years or so, only those stars within that distance would be so affected. The number of such stars is comparatively small. Beyond that distance all stars would be dimmed the same amount as far as any obscuring power of this local cloud is concerned. It has been argued that, since blue light is scattered by small particles much more than red light, the more distant stars should appear redder than the nearer ones, whereas in general we find that the more distant stars are the bluer ones. It is easy to see, however, that the effect would not be a progressive one unless the hypothetical cloud extended to the remotest stars. Furthermore, to produce the selective scattering it would have to be composed of the finest dust powder imaginable. A gathering sea fog dims and ultimately obscures the distant lighthouse without in any way altering its color. The small particles in this case are too big to introduce a selective absorption or scattering. If there were a sufficient number of stars within the limits tentatively set to our local cloud, and the cloud contained a large enough percentage of the finest pulverized matter, then we might expect to find some tendency for the stars near the boundary of this cloud to appear redder than those closest at hand. Apropos of this delicate test, Professor King, of the Harvard Observatory, has recently announced that he does find some unmistakable evidence that the nearest stars of a given class are somewhat bluer than similar stars seen at a greater distance. He believes that his results support this circumsolar cloud hypothesis.

While many of the bluest stars are at great distances from the earth, there is nothing against the supposition that these terrifically hot stars would appear actually bluer than they do, were it not for the presence of some amount of selective scattering which reduces the percentage of the light of shorter wave-lengths reaching the earth. I would suggest as a further bit of evidence in this direction the well-recognized discrepancy between the theoretical temperatures of the stars and temperatures derived from observational data. For many years the temperatures of stars have been determined observationally by measuring the distribution of the light intensity throughout their spectra. According to well-known laws of radiation expressed by Wien and by Planck the wave-length of the part of the spectrum showing the maximum intensity of illumination is an index of the temperature of a luminous body. The temperatures of the stars derived in this way have generally been found to be lower than those deduced from modern atomic considerations in accordance with

the ionization theory of the Indian physicist, Saha. This discrepancy can perhaps be reconciled if we allow for a small deficiency in the blue light of the spectrum of the hottest and more distant stars caused by the selective scattering from a cosmic dust cloud.

Ionized Calcium

An irrefutable argument for the mere existence of interstellar matter is to be found in the almost universal presence of the dark absorption lines of ionized calcium in the spectra of stars. These lines do not shift about with other lines in a star's spectrum in accordance with Doppler's principle, and give silent testimony to the existence of vast clouds of calcium lying between us and the distant stars. Eddington in his "Stars and Atoms" estimates that in all space within our galactic system there must be on the average one atom of calcium for every cubic inch. While the existence of calcium atoms in interstellar space would readily account for the selective absorption of light as represented by the dark calcium lines, these atoms would not of themselves cause any general dimming in the light of the stars shining through. A general dimming would have to be caused by lumps of matter larger than single atoms. If, however, we have such unmistakable evidence for some of the building blocks of matter permeating all space, does it seem unreasonable to suppose that there should exist aggregations of these building blocks in bundles of sufficient size to cause appreciable obstruction to the light from distant stars?

Again, apropos of this thesis we may do well to note that the stars in general appear to be only about one tenth as luminous as Eddington says they should appear on theoretical grounds. This is the equivalent of saying that, as the astronomer measures brightness, the majority of the stars appear about two and a half magnitudes fainter than they should. Calculation shows that, with no allowance for scattering, an obscuration of light of this amount could be produced by opaque particles a millimeter in diameter distributed more or less uniformly throughout a cloud a hundred light years in diameter with but one such particle to every one hundred and forty cubic miles. Even so the density of the hypothetical cloud would be less than one million million millionth (1×10^{-19}) that of air, and the total mass would be about that of 200,000 stars the size of the sun. Allowing for scattering, the amount of matter needed to produce the effect would be much less.

Possible Effects on Solar Radiation

Whatever further researches may reveal in regard to this problem, it seems most certain that, in the sun's migrations through the universe, the solar system must often encounter some vast clouds of the Milky Way. What the effect on the earth may be in such circumstances it is interesting to reflect. If the cloud should be of considerable density it is more than likely that the temperature of the earth would be materially lowered. Observations of solar radiation have shown that in years of great volcanic eruptions the amount of heat received by the earth from the sun has been considerably less than the normal quantity. Notable instances of this occurred in the cases of Krakatoa, Pelée and Katmai.

On each of these occasions the terrific eruptive force of the volcano hurled tons of pulverized dust into the upper atmosphere which did not return to earth for many months. Carried by upper air currents it was spread in a thin layer around the entire globe. The dust particles acted much as a screen to the radiation of the sun and were undoubtedly responsible for the decreased

solar radiation reaching the earth during those years. If such can be the effect of a relatively thin shell of volcanic dust it is more than likely that the passage of the solar system through a cosmic dust cloud would result in lowering the temperature of the earth by several degrees. If such lowered temperature were to persist for any considerable length of time winter snows would cease to melt and an ice sheet of vast extent would gradually form in the otherwise temperate zones. This appears to be one of the most plausible explanations of the well-known glacial periods of geologic history.

To add zest to this contention we have only to note that the constellation of Orion which is completely enshrouded in nebulosity lies not far from the wake of the sun's motion through space. One of the darkest patches of cosmic fog ever photographed lies just south of the well-known nebula in the sword of Orion. Recent investigations at the Mount Wilson Observatory indicate that the luminous part of the great nebula itself is rendered visible by the action of the Orion stars upon the neighboring regions of a vast dark cloud. The part of the great nebula so rendered luminous must be as far away as the adjacent stars. This is about a hundred and fifty light years. The distance may be overestimated, however, as in obtaining such results no allowance has been made for a possible dimming in the brightness of the stars due to any absorption or obstruction of light by any portion of the nebula itself. Apart from this question, it appears that since the whole region of visible nebulosity covers an area of some twelve hundred square degrees, the distance from the earth to the borders of this great cloud may be but a small fraction of the estimated distance.

It seems more than plausible that at the times of the great ice ages several thousands of years ago the sun may have been in the region of space where existed a cosmic cloud of considerable dimensions. The wide variations in temperature which the earth has undergone for considerable periods in geologic time seem to be more satisfactorily accounted for on such a basis than on the supposition that the sun itself experienced any considerable variation in its output in the last hundred million years. Geologists tell us that the earth at present appears be emerging from the last glacial epoch and that balmier climates are in store. We might interpret this astronomically by supposing that we are emerging from the last encounter with any cosmic cloud of appreciable density and are perhaps just clearing the outer reaches of an attenuated region. What lies ahead and how soon the sun may again engulf us in an interspatial fog only imagination can venture to speculate. One ventures to suggest that investigations of the earth's cosmical environment will play an important rôle in the next decade of astronomy. To what degree interspatial matter may yet modify our view of the universe only the most painstaking research can safely divulge.

CHINESE ALCHEMY

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ALCHEMY appears to have arisen spontaneously in China, possibly as an outgrowth from the magical and fantastic side of the Taoist religion. As early as the second century before Christ, perhaps earlier, Chinese alchemists were engaged in the study of mineral substances, particularly cinnabar, in the hope of finding the elixir of immortality and the philosopher's stone. They sought to convert base metals into gold, not because of the intrinsic value of that metal, but because artificial gold, if used as the material for eating vessels, was supposed to produce longevity. The priority of Chinese alchemy now appears to be well established.[1] The similarity of its aims and its materials with those of the later Greek, Arab and medieval Latin alchemy has led scholars to infer that they all derive from a common source,[2] or even to conclude that European alchemy probably had its origin in that of the Chinese.[3] At any rate, definite trade routes between China and the Roman Empire were established, mainly by way of Alexandria, as early as the first or second century of the Christian era, at a time when alchemy was certainly well developed in China but at least a century before the active rise of alchemy in Alexandria.

TAOIST ORIGINS OF CHINESE ALCHEMY

Whether Chinese alchemy arose out of the magical and fantastic side of the Taoist religion, as Johnson and others believe, it nevertheless seems to be the case that Taoism and alchemy attracted the same scholars. The same individuals practiced both professions and wrote upon both subjects. The Taoist Canon contains many treatises on alchemy and is a veritable treasure-house ready for future students of Chinese alchemy. Wieger's bibliography[4] of Taoism lists 1,464 titles of which 132 indicate that the treatises relate to alchemy. Of these 132, twenty-one titles suggest that the treatises deal with the spiritual, moral, metaphysical, physiological or mystical side of alchemy. Alchemy of spirit and alchemy of matter had the same confusion, or perhaps liaison, among the Chinese that they later had among the Europeans.

WU-HSING AND YIN-YANG[5]

Long before the founding of Taoism by Lao Tzŭ (1088)[6] (604–500 B. C.), the Chinese had very definite notions relative to the constitution of natural things. Wu-hsing (the quintet), water, fire, wood, gold (or metal) and earth, were regarded as the material principles of natural objects. The term, Wu-hsing, at first had no magical significance. One of the earliest cases of its use is in the Hung-fan (Great Plan) chapter of the "Book of Historical Documents": "In

[1] The Reverend Joseph Edkins, *Trans. China Branch Roy. Asiatic Soc.*, Hong Kong, 1855, part 5, pp. 83–99. J. R. Partington, *Nature*, 119: 11, 1927; 120: 158, 1927. B. F. Read, *Nature*, 120: 877–878, 1927.

[2] H. E. Stapleton, R. F. Azo and H. M. Husain, *Mem. Asiatic Soc. of Bengal*, 8: 405–406 (footnote), 1927.

[3] Obed S. Johnson, "A Study of Chinese Alchemy," The Commercial Press, Ltd., Shanghai, 1928.

[4] Dr. Leon Wieger, S. J., "Taoisme," 2 vols., Ho-kien-fou, 1911, 1913.

[5] Ch'i-Ch'ao Liang, "On the Origin and Evolution of the Doctrines of Yin Yang and Wu-hsing" (in Chinese), *Eastern Miscellany*, Shanghai, Vol. 20, No. 10, pp. 70–79, 1923. Translation by Lu-Ch'iang Wu.

[6] In order to avoid confusions of identity, the names of Chinese individuals are followed by the numbers which correspond to them in Giles' "Chinese Biographical Dictionary," London, 1898.

the olden days, so I heard, in the time of Kun (1018), a deluge overran the Kingdom putting Wu-hsing at nought." Liang says that this ought to be interpreted as meaning that on account of the deluge all the things which can be classified by Wu-hsing (or the five categories) became unavailable for man's use. The Hung-fan chapter says further:

> Wu-hsing [the quintet]: first, water; second, fire; third, wood; fourth, gold (or metal), and fifth, earth. Water is that which soaks and descends; fire that which blazes and ascends; wood that which is straight and crooked; gold (or metal) that which obeys and changes, and earth that which is of use for seed-sowing and harvest. That which soaks and descends becomes salt; that which blazes and ascends becomes bitter; that which is crooked and straight becomes sour; that which obeys and changes becomes acrid, and from seed-sowing and harvest comes sweetness.

The Wu-hsing are here plainly the constituent elements of material things. Tso Ch'iu Ming (2024), disciple of Confucius (1043), said that "nature provides the five materials and the people use them all."

Although the term, Wu-hsing, at first meant only the five elements, it later took on an occult and magical connotation and was used in connection with the five ways of righteous conduct, the five social relationships, the five virtues, the five tastes, the five colors, the five tones, etc. The earliest and most fantastic and systematic treatment of Wu-hsing occurs, according to Liang, in Lü Shih Ch'un Ch'iu Shih Er Lan by Lü Pu-wei (1455) (died 235 B. C.). It was later adopted in Hsiao Tai Li Chi by Tai Shêng (1853) (second to first century B. C.) and still later by Huai Nan Tzŭ (1269) (died 122 B. C.). Liang says that:

> The seasons of the year were thus divided among the Wu-hsing: spring, *wood;* summer, *fire;* autumn, *gold;* winter, *water,* and, in order to complete the story, they even went so far as to assign the interim between summer and autumn to *earth.* In a similar manner the magic quintet was correlated with the five locations: east, west, north, south and center; with the five colors: blue, red, yellow, white and black; with the five tones: Kung, Shang, Ko, Cheng and Yü; with the five tastes: sour, bitter, salty, astringent and sweet; with the five animated species: furred, shelled, scaly, feathered and nude; with the five worships: of wells, of furnaces, of doors, of eaves and of sacred roadways; with the five grains; with the five domesticated animals: horse, ox, sheep, dog and hog; the five internal organs of the human body: heart, liver, lungs, pancreas and kidneys; with the five rulers of ancient China: T'ai Hao, Yen Ti, Huang Ti, Shao Hao and Chuan Hsu, and with the five gods: Chü Wang, Chu Yung, Ho T'u, You Show and Hsuen Ming. . . . Thus the thousand and one entities of the universe have been ruthlessly forced into five categories corresponding to Wu-hsing. This fantastic mood has been dominating the mind of the nation for at least two thousand years and more, and has often manifested itself in deeds. It holds sway over the medical profession which has our lives in its hands. It is incarnated in our national flag.

While the notion of Wu-hsing as a genuine scientific concept (in its original meaning of the five elements) remounts to the twelfth century B. C., the scientific notion of Yin-Yang, or the two contrary principles, appears to have become definite at a later time, probably after Confucius (1043) (551–479 B. C.). Wu-hsing and Yin-Yang occur frequently in the writings of the Chinese alchemists, and they have real scientific meaning and usefulness. But they are also often aligned in magical and fantastic relationships in a manner similar to that in which the Alexandrian and Latin alchemists of Europe handled the notions of the contraries (sulphur and mercury, for example), and of the numbers three, seven, etc.

Yin, according to Liang, originally had the meaning of covering the sun with clouds. It came to mean shaded, dim, beclouded and, since Chinese cities were generally laid out with the principal entrance on the southern side, it meant the northern or shaded side of the city, also the south side of a river, the

interior, the reverse and the north side of a mountain. The word Yang originally signified "the bright aspect of banners fluttering at sunrise," but it soon acquired the meaning of the brilliancy of the sun, hence sunlight, warmth, the face-side, the exterior, the south side of a city or of a mountain. The couplet Yin-Yang was used to signify opposites, such as north and south, reverse and obverse, and this was without magical connotation and without the belief that the opposites were scientific categories by which the endless diversity of nature might be understood and classified. The words Yin and Yang, moreover, were used separately more often than they were used together.

Liang states that the I Li, or "Book of Rites and Ceremonies," does not contain either of the words. In the Shih Ching, or "Book of Poetry," the word Yin is used eight times; the word Yang, fourteen times, and the phrase Yin-Yang, only once and then in its original meaning of light and shade. The I Ching, or "Book of Change," uses Yin only once and Yang not at all. The commentaries on the "Book of Change" which are ascribed to Confucius are devoted to an exposition of that philosopher's dualism. He conceived the universe as embracing two kinds of forces which by interaction gave rise to the diverse facts of nature. The forces were not easy to describe; and he referred to them as Kang Jou, hard and soft; Tung Tsing, motion and rest; Hsiao Hsi, subtraction and addition; Ch'ü Shen, bending and unbending; Wang Lai, going and coming; Tsin T'ui, going forward and backward; Hsi Pi, folding and unfolding; as well as Yin Yang; but the latter is much less frequently mentioned than some of the other pairs. In short, Yin and Yang, as used by Confucius, had no magical connotation but did have, along with other pairs of terms, a certain philosophical and scientific value for the discussion of natural phenomena.

The notion of Yin-Yang gradually became extended until in the writings of the Taoists and alchemists it appears as a fundamental cosmological concept having innumerable fantastic associations. It was supposed that the primal matter, T'ai Chi, in its gyrations gradually separated into two parts. The heavy and gross part, Yin, settled and formed the earth, while the fine and light part, Yang, remained suspended and formed the heavens. Together they were the Liang I, or the two regulating powers, and constituted the soul of the universe.

Yin was regarded as the female element, typifying in general the more undesirable phenomena of nature, such as cold, darkness, weakness and death. Yang was regarded as the male element, which was, in turn, representative of the qualities in direct opposition to those of the Yin. From the interaction of these two cosmic forces, the universe was created and, in its various phases, directed and controlled. As time went on, this principle of dualism came to be a most potent factor in Chinese thought, for it permeated both the material and the moral world. At a later date, it was adopted as one of the cardinal beliefs of Confucianism, and as such it has exerted a momentous influence on the Chinese mind for more than twenty centuries.[7]

Prior to the time of the Feudal Kingdoms (722–481 B. C.) the phrases Yin-Yang and Wu-hsing were of rare occurrence and possessed only their ordinary meanings. They do not occur together in the writings of Confucius, Lao Tzŭ (1088), Mo Tzŭ (1537), Mencius (1522), Hsün Tzŭ (807) or Han-fei Tzŭ (614). Liang believes that the doctrines of Yin-Yang and Wu-hsing were first elaborated and spread by the divinationists, astrologers and magicians of Yen and Ch'i (the present provinces of Shantung, Honan and Chihli), in particular by Tsou Yen (2030) (fourth to third century B. C.), Liu Hsiang (1300) (80–09 B. C.) and Tung Chung-shu

[7] Johnson, *op. cit.*, pp. 14, 15.

(2092) (second century B. C.). Although the writings of Tsou Yen are no longer extant, their purport can be gathered from the references to them in the historical writings of Ssu-ma Ch'ien (1750) (born about 145 B. C., died 86 or 74 B. C.). Liang concludes that Tsou Yen "was the fanatic who started the uncomely and uncouth doctrines." Ssu-ma T'an (1762) (died 110 B. C.), the father of Ssu-ma Ch'ien, placed Yin-Yang-ism on a par with Confucianism, Taoism, Mo-ism, Nominalism and Legalism, and wrote an essay on the "Essence of the Six Schools." We infer that by his time the doctrines had been pretty fully elaborated into the form in which they pervade the writings of the alchemists.

Alchemists and Alchemical Writings

Ch'in Shih Huang Ti.—Ssu-ma Ch'ien succeeded his father as grand astrologer or grand annalist to the Chinese court and completed the Shih-chi, or "Historical Memoirs," which his father had commenced. The Shih-chi deals with the history of China from the earliest times to 122 B. C. It tells of the islands of the immortals and reports the earliest organized attempt in Chinese history to secure the elixir of life. It is reported that in the midst of the Eastern Sea there are three supernatural islands. Their names are P'eng Lai, Fang Chang and Ying Chou. It is there that the immortals may be found, and the drug which prevents death. The Emperor Ch'in Shih Huang Ti (1712) (259–210 B. C.), the same who established a new dynasty, built the Great Wall and introduced the hair-pencil or brush for writing on silk instead of on bamboo tablets, became interested by the report of these islands and especially by what he heard concerning the elixir of immortality. He was influenced by the magicians Lu Shêng (1428) and Hsü Shih (788) to organize an elaborate naval expedition for the purpose of searching for them.

> He gave to Hsü Shih seeds of the five grains and dispatched him upon his voyage with three thousand young men and women, and laborers for all kinds of work. Hsü Shih sailed away, and discovered a locality noted for its peace and fertility. There he tarried, was made king, and did not return.

The Emperor, however, continued to hope. He made several pilgrimages to the eastern coast of China. He consulted with magicians, but feared to trust himself to the sea.

> It was his custom to promenade up and down the seashore, in the hope that he might in some manner obtain the wonder-working drug of the three sacred islands in the midst of the sea—but he never obtained it. He returned to Sha Ch'iu—and there he died.[8]

Li Shao Chün and Han Wu Ti.—The historian Ssu-ma Ch'ien also tells of an alchemist, Li Shao Chün (1189), who flourished at the court of the Han Emperor, Wu Ti (1276) (156–87 B. C.).

> He constantly affirmed that he was seventy years of age, that he was able to rule over spiritual matters and that he could escape old age. . . . He traveled about in order that reports of his prowess might reach the ears of nobility. . . . He excelled in showing himself shrewd, and in saying things at the same time astounding and accurate.

Through his influence the Emperor became interested in alchemy. Li Shao Chün said, "I know how cinnabar transforms its nature and passes into yellow gold. I can rein the flying dragon and visit the extremities of the earth. I can bestride the hoary crane and soar above the nine degrees of Heaven." He gave particular instruction to the Emperor. "If you will make the sacrifice of the furnace, you will be able to transmute cinnabar into gold. When the gold shall have been produced, you may make of it utensils for eating and drinking. Through using them your life will be prolonged, so that you may see the blessed immortals of the islands of

[8] Johnson, *op. cit.*, pp. 66–68.

P'eng Lai, which lie in the midst of the ocean. When you shall have seen them, and shall have made proper sacrifices to high heaven and broad earth—then you will never die." It is further recorded that

> it was after this discourse that the Son of Heaven [the Emperor] for the first time performed in person the sacrifices of the furnace. . . . He occupied himself in experimenting with powdered cinnabar, and all sorts of drugs, in order that he might obtain gold.[9]

Liu An or Huai Nan Tzŭ.—Liu An (1269) (died 122 B. C.) was a grandson of the first Han Emperor, prince of Huai Nan, and an ardent Taoist and alchemist, a searcher after the elixir of immortality and the secret of the transmutation of the metals. He praised the art of proper breathing, saying that "he who consumes the atmosphere becomes spiritual and attains extreme old age." He also spoke of the regions of the extreme West "where there are rock cities and gold dwellings, and where human beings and wild animals 'drink the atmosphere' and do not die." He taught that "gold grows in the earth by a slow process, and is evolved from the immaterial principle underlying the universe, passing from one form to another up to silver and then from silver to gold." Under the pseudonym of Huai Nan Tzŭ he wrote a treatise which contains considerable alchemy, and his Hung lieh chieh ("Story of the Great Light") deals with cosmogony and embodies alchemical doctrines. Both works are part of the Taoist canon.[10]

Wei Po-Yang.—The Taoist philosopher Wei Po-Yang (2287) flourished about A. D. 142 and wrote the Ts'an T'ung Ch'i, a "Treatise on Alchemy," which is based upon the "Book of Change" and is regarded as the earliest purely alchemical treatise in the Chinese language.[11] It is included in the Taoist canon and in the Ssu-ku-ch'uan-shu (Imperial Encyclopedia). A recently printed text consists of eighty-two chapters and an additional section entitled "The Song of the Ting (Furnace)."

The Ts'an T'ung Ch'i makes frequent reference to the pill of immortality and contains abundant evidence of an earlier alchemical tradition. It mentions the obscurity of earlier writers and states that its author is making an effort to be clear in spite of his feeling of inferiority and inadequacy for the task. It describes the processes about as lucidly as the writings of the medieval alchemists. It gives symbolic and imaginative names to many of the substances which are used, and insists upon the necessity for careful and accurate compounding and for a cautious interpretation of the text which, the author says, he has intentionally obscured in places. In many respects it bears a strong resemblance to the later alchemical writings of the Europeans.

> In order that the [ancient] writings on fire shall not have been in vain, I explain here in simple language.
>
> Like the moon lying on its back is the shape of the furnace and the pot. In it is heated Pai Hu [White Tiger]. Kung Jih [Mercury Sun] is the flowing pearl and with it is Ch'ing Lung [Blue Dragon]. The East and the West merge together and so the Yün and P'eh[12] restrain one another.
>
> When gold is placed in a hot fire, it is not deprived of the brilliancy of its color. Since the days of the unfolding of the Universe, the sun and the moon have not diminished in brightness nor has gold lost any weight. The shapes of the sun and moon have always been

[9] Johnson, *op. cit.*, p. 70, footnote; pp. 76–77.

[10] Johnson, *op. cit.*, pp. 47, 75, footnote. Sarton, "Introduction to the History of Science," Vol. I, p. 193, Baltimore, 1927.

[11] An English translation of this work is at present in course of preparation by Lu-Ch'iang Wu. We quote portions of it.

[12] Yün denotes the lighter element of man's nature and P'eh the heavier and more earthly. Upon death the former rises to the skies while the latter stays and is buried with the body.

the same. Gold is born under the influence of the moon. At daybreak, receiving magic force from the sun, it returns to its mother. Being enveloped by the sun at the wane of the moon, it hides within the walls and abandons itself to inanity. Thus does the gold regain its original nature. Only when intense brightness is obtained is the Ting [furnace] well heated.

Tzŭ Wu amounts to three and Wu Chi is called five. The three and the five having been harmonized, the eight stones are put into proper order. They desire one another's presence in their inhalation and exhalation, and they long to be man and wife. Yellow earth is the father of gold and flowing pearl is the mother of water. Earth is the Kwei [ghost] of water and it is not able to arise because of the overbearing of the earth. The Chu Ch'ueh [Red Bird or the seven fixed stars of the southern sky] is the spirit of fire and dispenses victory or defeat with justice. With the ascendance of water comes the vanquishing of fire. Dying together they return to Mother Earth. The three natures merge together and thus show their common origin.

Longevity counts very much in the great triumph. Huan Tan [Returned Medicine] is edible. The nature of gold is non-corruptible and it is therefore the most valuable of things. The Shu Shih feeding on it attain longevity. . . . The Chin Sa [gold dust], being in the internal organs, spreads foggily like wind-driven rain. Vaporizing and permeating, it reaches the four limbs. Thereupon the complexion becomes rejuvenated, hoary hair regains its blackness, and new teeth grow where fallen ones used to be. If an old man, he will once more become a youth; if an old woman, she will regain her maidenhood. Such transformations make one immune to worldly miseries, and one who is so transformed is called by the name of Tsun Jen.

Hu powder, on being placed in the fire, becomes discolored and changes back into lead. On treatment with hot liquids, ice and snow dissolve into T'ai Hsuen [*i.e.*, an exceedingly intangible principle]. Gold is chiefly made up of sand and derives other properties from mercury. The transformations concern only the essence of the materials. Causes and effects are traceable in the course of the changes. The way to make oneself a Fu Shih Hsien [a drug-using supernatural being] lies in the use of drugs of a nature similar to oneself. For rice seeds are used in the raising of rice, and chicken are hatched from hen's eggs. . . . Fish eyes can not replace pearls, and tall weeds can not be used for timber. Things of similar nature go together. Queer things can not be realized. This explains why the swallow does not give birth to peacocks, and the fox and rabbit do not mother horses. This also explains why flowing water does not heat up what is above it and why moving fire does not wet what is under it.

Many are the learned scholars, but they are too profound to be understood and are therefore lost to the world. They never meet with proper patronage. Their belongings are devoured by devastating fire. They follow the printed word and sometimes they follow their blind inclinations. The start they make is improper and subsequent regulation is wanting.[13] Chiang Shih Tan [a kind of stone], mother-of-pearl and alum are crushed together and cured. Sulphur is burned with Yü-Chang wood. Mud and mercury are treated in a mixture. This forms the pivot of the five stone coppers under the drum. Things of different nature and kind are unwilling to unite and live together.[14] Ten thousand defeats will come from a thousand attempts. Doubts will fill the heart in middle age. . . .

The Essay on Fire comprises six hundred chapters. Their subject-matters are not the same. They are so cautiously worded that they are not easily understood by people of the world. When things are traced back to their origin, it will be found that the bright and the

[13] Compare Albertus Magnus in the treatise "De Alchemia": "For I have seen certain men who made their sublimations with great diligence but were not able to proceed farther because they did not have the fundamentals. And I have seen others who had a good beginning but because of too much potation and other vanities were not able to accomplish the work." And, in the advice which he gives to the person desirous of undertaking the study of alchemy, "The fourth precept is that the worker in this art should be sedulous and frequent in his operations, and should not tire but should persevere to the end. Because, if he should begin and should not persevere, both time and substance would be lost." "Theatrum Chemicum," Vol. II, pp. 487, 491, Ursellis, 1602.

[14] The author of the "Speculum Alchemiae," which is ascribed to Roger Bacon, insists upon the fact that the philosopher's stone can transmute only a substance which has a nature allied to its own. "On this point I now reveal to you a great and hidden secret. One part ought to be mixed with a thousand parts of an allied substance, and the whole shut up tightly in a suitable vessel, etc. . . . always one part of this for another thousand of an allied substance." "Theatrum Chemicum," Vol. II, p. 442.

dark [the obvious and the obscure] are in close union. A profound thing like this is fit to be treated only by the wise. It is presumptuous therefore for me to write on it. But I can not hold my peace either; for it would be a great sin on my part not to transmit the Tao [Way] which would otherwise be lost to the world forever. I will not write on silk lest the divine secret be spread abroad. In hesitation I sigh. . . . Details of the processes shall not be entirely divulged. Only the more important principles shall be set forth.[15]

Gold should be used for the embankments, for then the water and the fire can have their proper play. The number of gold is fifteen; so is that of water. Take measurement when the process is about to begin. One half water is more than enough. The two things will be made into an essence—enter into one another, undergoing marvelous changes. The T'ai Yang Ch'i [the Most Positive Ether] which is underneath gives rise to distillation instantly. Liquefaction takes place first, followed by solidification. This is known as Huang Yü [Yellow Carriage]. . . . It is bodily transformed into a white dust resembling that deposited on a well-lighted window sill.

Treatment and mixing will bring about combination and rapid entrance to the scarlet portal. The escape must be firmly blocked. Below the flame plays noisily on the under side day and night. The flame at the start should be weak, and it should be made strong at the end. Close attention and careful watch should be given so as properly to regulate the temperature. Revolve about the twelve sections. At the end of that a closer watch should be accorded. As the breath expires life is ended. Death expels the spirit. The color changes to a purple.[16] Behold! the Huan Tan [Returned Medicine] is obtained. This is then made into pills with the help of wieldy knives and blades. . . .

Huan Tan [Returned Medicine] is obtained only when gold has returned to its original own. I do not dare say things without ground, nor imitate the sayings of the sages. The ancient "Treatise on Fire" takes note of the Dragon and the Tiger; Emperor Huang Ti (1712) praises the Flower of Gold; Huai Nan Tzŭ (1269) assays the Ch'iu Shih [Autumn Stone]; and Wang Yang (?) adds Huang Ya [Yellow Shoot] to this series of achievements. The sagacious follow the discipline strictly. The unworthy can not aspire to this. The way has been one since ancient times. One's projects are to be divulged only on personal interview. The student should be industrious and thoughtful. Important things have been set forth plainly. They are unmistakably clear.

The author speaks of the difficulty of the art and of the necessity for right judgement.

People like trivial acts. They do not understand the Tao [Way]. Abandoning the right road and following vicious by-paths in the hope of pursuing a short cut, they finally find themselves to be at the closed end of a blind alley. This is like the blind man who goes about without the help of a staff, or the deaf man who goes to listen to music. One might as well look for rabbits and birds under water, or try to get fish and dragons in a mountain. One might as well plant wheat to get barley, or use a pair of compasses to draw a square. Energy is thus wasted and the spirit torn away for long years without success. However, it is a simple matter to learn the method of using internal medicine. . . .

It is difficult to make representations of things which one does not understand. One may spend so much of what he has as to bring want and hunger home to his wife and children and yet he will not be able to arrive at the truth. Many have there been who have thus

[15] Compare Albertus Magnus in "De Alchemia" (*loc. cit.*, pp. 486–487): "I who am truly the least of the Philosophers intend to write about the true art for my associates and friends, clearly and infallibly, but however in such manner that seeing, they may not see, and hearing, they may not understand. Wherefore I beg and adjure you, by the Creator of the world, that you hide this book from all stupid persons. To you indeed I will reveal the secret, but from others I conceal the Secret of secrets because of the envy of this noble science. For the stupid despise it because they are not able to grasp it, and thence hold it hateful and believe it not to be possible, and so envy those who work at it and call them forgers. Therefore beware lest you reveal any of our secrets in this operation. Again I advise you that you be cautious, persevere in the operations, and avoid fastidiousness for you know that great utility follows after your work."

[16] The Alexandrian alchemists regarded purple as the noblest of the colors. In the process of the transmutation of a base metal into gold there were various changes of color, and the appearance of a purple marked the completion of the process. From the time of Zosimos, about 400 A. D., it was understood that the color sequence was black, white, yellow and violet. *Vide* Arthur John Hopkins, *Isis*, 7: 58, 1925; also "Studien zur Geschichte der Chemie. Festgabe für Edmund O. v. Lippmann," Berlin, 1927, pp. 9, ff.

devoted themselves to the cause. But very few of these have met with the good fortune of success. In that they searched far and wide for reputed medicines they fell into a path which is incompatible with the Tao. One should take note of hints and clues *just as he would when he meets strangers.* The thing to do is to compare things by classes and to trace their beginnings and ends.

The following passage shows the fantastic language which the alchemists used occasionally:

Tan Sha [Red Sand or cinnabar] is of wood and will combine with gold. Gold and Water live together: Wood and Fire keep one another company. The four are in a confused state. They are classified as Tiger or Dragon. The magical number of the Yang Dragon is odd and that of the Yin Tiger is even. The blue pancreas is the father and the white lungs is the mother. The black kidneys are the sons and the yellow spleen is the grandfather. The three things are of the same family and they all belong to the ordinal numbers of Wu and Tsih.

The necessity for accuracy:

When compounding is not properly made, law and order will be upset. Under such conditions, even with Huang Ti (1712) to operate the furnace, with the Supreme One to confer blessing on the operation, with the Eight Deities to help compounding, with Huai Nan (1269) to control the fire, with prayers offered on bended knees on a dignified altar in a magnificent temple decorated with jades, with sacrifices of Lin [a sacred animal] and of Feng [a sacred bird] made to the spirits by the purified and dieting seeker in the vain hope of success, even then failure will still be inevitable. For this is just as absurd as repairing a cooking vessel with glue, or trying to heal a boil with Nu [sal ammoniac], or trying to get rid of cold with ice, or attempting to get rid of warmth with a hot fluid, and reports of flying turtles and dancing snakes.

The reason for the treatise:

Oh, the sages of old. They held in their breasts the elements of profundity and truth. Having prepared and partaken of the medicines prepared in the nine Tings [Furnaces or Vases, usually with three legs], they were endowed with the power to disappear at will. They held the essence firmly and cultivated their spirit, and they thereby attained communion with the *three primes.* The essential fluids worked properly to give them strong bones and muscles. The various evils were banished forever and the good Ch'i came to stay forever. In the course of time they became deities. Their sympathy, for those of posterity who have a liking for the attainment of the Tao, caused them to explain the writings of old with words and illustrations. They expressed their ideas by the names of stones and in vague language. Those who understood their sayings held their peace. The secret was handed down in the family from generation to generation. The world at large was ignorant of it. In the attempt to learn it the politician cut short his career, the farmer neglected his farm, the merchant stopped trading and the ambitious scholar became poverty-stricken. These grieve me. Therefore I execute the present writing. Although concise and simple, yet it embraces the essential points. The proper quantities to be used are put down for instruction, together with confusing statements. But the wise man, by using his own judgment, will be able to profit by it.

Another description of the process:

Above cooking and distillation occur in the pot: below blazes the roaring fire. Afore goes the White Tiger, leading the way: following comes the formation of the gray liquid. The fluttering Red Bird flies the five colors. Encountering ensnaring nets it is helplessly pressed down and cries with pathos like a child after its mother. Willy-nilly it is put into a pot of hot liquid to the detriment of its feathers. Before half of the time has passed dragon scales appear with great rapidity and in great numbers. The five dazzling colors change incessantly. Turbulently boils the liquid in the Ting. One after another they come, irregular like the teeth of a dog. Stalagmites are spit out which are like midwinter icicles. Rocky hills appear with no apparent order, supporting one another. . . .

This is indeed a marvelous art that I am writing about. I am speaking with deliberation. This is meant to be transmitted to posterity through thousands of years for their reference. This to them should be as bright as the stars crossing the milky way and as sure as the rivers running into the sea. The aspirant should study this with diligence and care. Revelation will come to bring him enlightenment. Careful study will open the doors to the secrets. Nature's Tao shows no partiality, but reveals to those who are worthy.

In Pao P'u Tzŭ, Ko Hung (978) states that

> Wei Po-yang was the "Father of Alchemy," and had three disciples who went into the mountains to make medicines. When made, they first tried them on dogs to see if they were fatal or immortal in their effects. Dogs died when fed on them; one of the disciples ate one and he also died. Wei Po-yang also ate one and died, etc. When they were being put into their coffins they resurrected.[17]

Ko Hung or Pao P'u Tzŭ.—The Taoist alchemist and physician, Ko Hung (978) (about A. D. 281–361), was born at Chiang-ning-fu in Kiangsu. At some time after the year A. D. 326, he requested the Emperor Yüan Ti (1350) to send him to Kou-lou because cinnabar, which he needed for his experiments, could be obtained there from Cochin-China. He wrote two important medical works, as well as the pseudonymous Pao P'u Tzŭ, a treatise on Taoist alchemy, dietetics and magic which had considerable influence on the development of Taoist doctrines and superstitions.[18] A text of this work occupies six volumes or fascicules (three for the "Inner Chapters," three for the "Outer Chapters") of a recently printed edition of the "Collected Taoist Classics."[19]

Johnson[20] quotes from Pao P'u Tzŭ directions for the preparation of the pill of immortality:

> Take three pounds of genuine cinnabar, and one pound of white honey. Mix them. Dry the mixture in the sun. Then roast it over a fire until it can be shaped into pills. Take ten pills of the size of a hemp seed every morning. Inside of a year, white hair will turn black, decayed teeth will grow again, and the body will become sleek and glistening. If an old man takes this medicine for a long period of time, he will develop into a young man. The one who takes it constantly will enjoy eternal life, and will not die.

[17] Read, *loc. cit.*, trans. Yung.

[18] Sarton, *op. cit.*, p. 355.

[19] The Commercial Press, Ltd., Shanghai, China.

[20] Johnson, *op. cit.*, p. 63.

Another quotation[21] from the same work suggests that Pao P'u Tzŭ, like the Alexandrian alchemists, regarded the transmutation of metals as being accomplished by transmutation of color. "Whiteness is the property of lead. But if you cause it to become red, the lead will change into cinnabar. Redness is the property of cinnabar. But if you cause it to become white, the cinnabar will change into lead." Possibly the passage indicates a confusion between red lead and cinnabar.

Edkins[1] has argued that Chinese alchemy arose out of the fantastic side of Taoism and has supported his arguments, in part, by quotations from Pao P'u Tzŭ, which, he says, "contains an accurate account and obstinate defense of the system" as it existed in Ko Hung's time. The excellence of the translation, the inaccessibility of the *Transactions* in which it is published and the general paucity of material on Chinese alchemy make it worth while to reprint here *in extenso* that portion of the translation which relates especially to alchemy.

> We often hear the golden elixir spoken of, but people do not talk of it as being attainable in our own time: they all say that the genii of olden times only were acquainted with the elixir. Now the reason of this incredulity is, that in the current recipes for it, many errors and deficiencies exist. Formerly, Tso-yuan-fang (2028), after meditating profoundly, was accosted by a spiritual being, and presented by him with the "Book of the Elixir of Immortality" (Chiu-tan-hsien-ching). When the Han dynasty was falling, he withdrew from the troubles that then agitated the world to a mountain retreat. His pupil was my instructor, and from him I received several works on the elixir; others therefore have had no such advantages as I for knowing the secret of this preparation. For more than twenty years it has been in my hand. Alas! I could only lament, being poor, the want of means to make trial of it. Corn supports the life of the people; without it they die. Of how much more value must this wonderful medicine be! The golden elixir, the longer it is subjected to

[21] *Ibidem*, p. 74.

the action of fire, passes through transformations more and more remarkable. Gold when it is melted never diminishes; if buried in the earth, however long, it never rots. By taking these two substances as medicines, the human body may also be protected from decay, and acquire immortality. It is to external things that we must look for a preservation of life, just as by pouring oil on fire we increase its activity and prevent its destruction.

I write for those who have sought in vain for a teacher who could communicate to them the highest form of wisdom; for them I transcribe some parts of the works I possess on the golden elixir. . . . When vegetable matter is burnt, it is destroyed, but when the *tan sha* [cinnabar] is subjected to heat, it produces mercury. After passing through other changes, it returns to its original form. It differs widely therefore from vegetable substances, and hence it has the power of making men live forever, and raising them to the rank of the genii. He who knows this doctrine—is he not far above common men? In the world there are few that know it, and many that cavil at it. Many do not even know that mercury comes out of cinnabar. When told, they still refuse to believe it, saying that cinnabar is red, and how can it produce a white substance? They also say that cinnabar is a stone—that stones when heated turn to ashes; and how then can any thing else be expected of *tan sha*. They can not even reach this simple truth—much less can it be said of them that they have been instructed in the doctrine of the genii. . . . For the sake of those in these later times who should be willing to be taught, the sages of antiquity transmitted a method by which they might be freed from death and misery. Is it too much to make a trial of this method? If you should gain thereby only two or three centuries of life, would not this slight addition to your existence be far better than the fate of the mass of mankind? Many fear to attempt seeking after immortality, lest they should fail and expose themselves to ridicule, as the victims of folly and deception. But if they should resolve at all risks, to obtain only this doctrine of immortality for the benefit of mankind, and succeed in it in one instance, would not those who had laughed be themselves deservedly laughed at?

The medicine should be prepared on a mountain, in a lonely spot, only two or three being present. There should be fasting for one hundred days previously, and perfect purification of the body. The parties should be all believers in the doctrine; and persons who would ridicule the undertaking, should be kept in ignorance of it, otherwise the preparation of the elixir would fail. When it is made, the successful manipulator will, with all his family, become immortal. Common men refuse to adopt this method, preferring to use medicines which are vegetable substances, forgetting that, being subject themselves to decay and destruction when placed in the earth or near the fire, they can not give life to man. The nine preparations that can confer immortality on man are not what persons of the common stamp should ever see or hear of. Stupidly they seek after riches and honors, and these alone. Like walking corpses, they pass through the world.

This passage is followed by a description[22] of the nine preparations. Alum, quicksilver, sodium sulphate, potash and oyster shells are among the substances which are used. In another section, Pao P'u Tzŭ enumerates several substances which may be regarded as materials for the elixir of immortality. Cinnabar, he says, is the most efficacious, gold second, silver third and fourth ling chë, a plant which confers everlasting happiness. He names various precious stones, medicines and vegetable products, seventeen in number, which are effective elixirs of immortality, but not all of them are effective in the same degree.

T'ao Hung-Ching.—The Taoist physician and alchemist T'ao Hung-ching (1896) was born at Mo-ling, Kiangsu, near Nanking, in 451. Just before his birth, his mother dreamed that a green dragon issued from her bosom and that two angels came to her house with a bronze censer in their hands. At the age of ten years, T'ao Hung-ching read the writings of Ko Hung and began to "pound drugs" with a view to discovering the secret of immortality. He was a handsome man, seven feet four inches tall, an enormous reader and an excellent performer on the lute. Before he had attained to full manhood, he was appointed by the Ch'i Emperor Kao Ti (714) to be tutor to the imperial princes.

[22] Summarized by Edkins but not translated at length.

He resigned that position in 492 and retired to the mountains in Hua-yang where he remained until his death in 536. He was known as the Hermit or the Saint of Hua-yang. He dwelt on the top floor of a three-storied tower, lodging his disciples on the middle floor and visitors on the floor below. The Liang Emperor Wu Ti (720) was among his visitors, before he mounted the throne; and, after his accession in 502, he offered to make T'ao his minister, but the latter refused to return to the world. The Emperor, however, consulted him on matters of importance, for which reason he was known as the "Minister in the Mountains." He passed his life in alchemical and similar research, practicing the method of breathing which is supposed by the Taoists to conduce to immortality, and trying to live without food. His chief amusement was listening to the sound of the breeze in the pine-trees. He wrote, or edited, one of the most important ancient treatises on materia medica, the Ming-i-pieh-lu. To the 365 drugs mentioned in the Shên-nung Pên-ts'ao (fourth century, B. C.), he added 365 others which had been recommended by the physicians of the Han and Wei dynasties. He wrote another treatise on materia medica, entitled Pên-ts'ao ching-chu, and other medical works. He wrote Tao-chien-lu, a treatise on famous swords, and edited, in or after 489, the Chên-kao, or "Declaration of the Genii," a work which is devoted to the magical and fantastic aspects of Taoism.[23]

Pi Shêng (1646) flourished under the Sung Emperor Jên Tsung (144), who reigned from 1022 to 1063. He was an alchemist and inventor, and devised, between 1041 and 1049, the art of printing with movable type. He used type made of clay and experimented with wooden type. The invention was later improved by an unknown person by the use of type made of tin, perforated and held in place by means of a wire. We have at present no information concerning his alchemical work.[24]

Tou P'ing (?) flourished in the first half of the eleventh century (?) and wrote Chiu P'u, a treatise on spirituous liquors which consists chiefly of brief notices regarding different kinds of liquor and celebrated distillers. His treatise may perhaps possess considerable significance, inasmuch as the art of distilling alcohol was probably unknown in Europe before the twelfth century.[25]

Conclusion

Chinese alchemy is a broad and largely unexplored field for study. The present paper scarcely scratches the surface of it. But it shows the sort of thing that will be found in it, and, we hope, makes clear the necessity for more detailed studies in this important chapter of the history of chemistry.

[23] Sarton, *op. cit.*, p. 436.
[24] *Ibidem*, p. 723.
[25] *Ibidem*, p. 723.

AERONAUTIC DEVELOPMENT

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SINCE the first flight by Orville Wright in a powered heavier-than-air machine, aeronautics has been in the course of development for a period of twenty-six and one half years. When we consider the magnitude to which the idea of the Wright brothers has grown and the fact that man has had a desire to fly like the birds almost from the beginning of time, this period is indeed a short one.

Although the principle and practicability of flight has been thoroughly demonstrated and established as something that was destined for the world to utilize for commerce and pleasure, the surface of great possibilities for aeronautics is just being scratched at the present time.

Three years after the dawn of the twentieth century, Orville Wright was carried off the ground for a few moments by a flying machine. Last year, over 25,000,000 miles were flown in scheduled operations by United States air lines, and nearly 160,000 passengers and 8,000,000 pounds of mail were transported over these lines. The passengers carried represented over three times as many as were flown the previous year, and the increase in the amount of mail carried was 100 per cent. Established route mileage of 36,000 in 1929 was more than double the miles in 1928, and the fact that miscellaneous commercial flying in this country increased from an estimated 60,000,000 miles in 1928 to 110,000,000 miles in 1929 is of special economic significance.

This splendid record serves only to indicate what may be accomplished in the next few years with properly coordinated development work on problems that continue to present themselves as aeronautics continues to make progress.

Congress, through the Air Commerce Act of 1926, delegated to the Secretary of Commerce the responsibility of encouraging and fostering the development of civil aeronautics in the United States and of regulating the use of aircraft in commerce. Soon after the passage of the act, the Aeronautics Branch was organized to carry out the details of the work. In order best to meet this assignment, the Aeronautics Branch has divided itself into three units, one dealing with air regulation, a second with the establishment and maintenance of airways and the third with aeronautic development. It is with this last-mentioned division that the Aeronautic Development Service of the Aeronautics Branch is primarily concerned.

The Aeronautic Development Service embraces all activities of the Commerce Department in connection with assisting communities in the selection and development of airports, the rating of airports, the promotion and correlation of aeronautic research, the publication and dissemination of aeronautic information, the publication of air navigation maps and airway bulletins and the general promotion work of the department looking toward the development of civil aeronautics.

An outstanding activity of the Aeronautic Development Service pertains to the development and improvement of aids to air navigation and the promotion of safety and comfort in flight. This work includes such activities as research on aeronautic radio, investigations on aeronautic lighting, wind tunnel studies, sound-proofing of airplane cabins and reduction of noise from engines and propellers, research on special airplane engine problems and investigations of

the strength of airplane joints and fittings.

Current work of the Aeronautic Development Service in the field of aeronautic radio includes the development of a convenient and reliable direction finder (radio-compass) for use on airplanes. This device will supplement the radio range beacon system of the federal airways by providing a means of navigation for pilots flying on independent routes. Experimental work is also being conducted on a number of problems having to do with the development of radio range beacons, such as adjustment of the directions of the several courses produced by the transmitter to fit the actual airways radiating from the transmitter; reliability tests on course direction as affected by such factors as lapse of time, time of day and distance from transmitter; the development of beacons giving simultaneously more than four courses from a single transmitter, and improvements in the receiving equipment. Also research is in progress on the simultaneous transmission of radio telephony and radio beacon service (using visual type indicator) on the same radio frequency. This includes the development of a transmitter which will send two types of signals without mutual interference.

In addition to such auxiliary radio problems as antenna design and ignition shielding, the service is also working on the development of a blind landing system for use at airports. Such systems, in general, include three elements, or their equivalent, to indicate to the pilot the position of the aircraft in three dimensions as it approaches and reaches the instant of landing. In the present experiments, lateral position (*i.e.*, the landing field runway direction) is given by a small directive beam of the same type as the beacon used for guidance along the airways but lower in power. Longitudinal position (*i.e.*, approach) is given by marker beams. Height is given by an inclined high frequency radio beam. This beam is directed on a small angle above the horizon and is used in such a way as to provide a very convenient gliding path for the landing airplane, beginning at any desired elevation and any desired distance from the landing field. The airplane does not fly on the axis of the beam but on a curved path whose curvature diminishes as the ground is approached and which becomes tangent to the landing area at a predetermined point.

Research is also in progress on the improvement of lighting devices at landing fields, such as wind indicators and boundary lights; the improvement of navigation lights and landing lights carried on aircraft; the study of landing field lighting requirements, including field methods for measuring low illuminations and photometric measurements on beacons, traffic signals and miscellaneous aeronautic lighting devices.

Aircraft engine research includes experimental work which has to do chiefly with perfecting mercury scales used to measure engine torque and developing improved methods of correcting the observed torque for the slip-stream reaction. This windage effect can be eliminated if it is possible to use an air-straightening grid of suitable design between the propeller and the engine. The effect of grid thickness, size of opening and over-all grid size are matters which can be determined only by actual experiments. The magnitude of the windage correction may also be determined by using another engine to spin the test propeller and measuring the torque due to the slip-stream above. Both methods must be tried out and checked by dynamometer calibration of the engine used.

Wind tunnel research includes the investigation of the stability of airplanes at low speeds and high stalling angles and the study of the effect of changes in the chord and span of ailerons on the rolling and yawing movements of air-

craft—at both low and high angles of attack. This work has a direct bearing on the control of airplanes at low speeds and high angles of attack and is a direct service to manufacturers, for its aids in determining the performance of a new type of airplane previous to actual construction. At the same time it advances the policy of the Aeronautics Branch of increasing safety in the air by affording information on the probable behavior of new types of aircraft.

Engineering research includes study of the various means of reducing the noise in the cabins of passenger airplanes and the general use of steel tubing—welded at the joints—in airplane construction. To date, the noise-reduction studies have met with much success in so far as they embody the insulation of the cabin. Studies of various types of muffling devices for engine exhausts and of methods of reducing propeller noise are under way. The general use of steel tubing welded at the joints, in airplane construction, has created a demand for more complete and reliable data on the strength and other properties of welded joints in structural members. This investigation has been undertaken as part of the program of the Aeronautics Branch in promoting safety in aviation.

The airport work of the Aeronautic Development Service falls into three main groups: (1) the direction and coordination of the work of the department related to assisting in the selection of airport sites and fostering the development of airports; (2) the promulgation of airport rating regulations and the rating of airports; (3) planning and preparation of airport publications.

This activity embraces conferences with municipalities and civic organizations desiring assistance in the selection of airport sites and requesting information regarding the requirements for the development of suitable airports. A small group of airport specialists are available for this work. These men are sent throughout the United States on carefully planned itineraries—the usual procedure calling for the inspection of a number of sites, perhaps a talk before a civic organization and a conference or series of conferences with officials interested in the development of the airports and desiring information regarding the requirements of the airport rating regulations of the Department of Commerce.

These specialists urge the importance of having experienced engineers make comprehensive studies and prepare plans for complete airport development, in order that every dollar invested in the project may be expended to the best possible advantage. It should be understood that the Department of Commerce representatives do not render this engineering service.

Another function of the Aeronautic Development Service relating to airports is that of rating airports upon application of the owner.

During the past twelve months, much time has been devoted to a study of the management aspects of airports and to a uniform system of field rules which will apply in whole or in part to airports all over the country. The need for such work is readily recognized in light of the fact that in the United States there are at present approximately 1,600 airports and landing fields in various stages of completion and some 1,100 airports proposed for early development.

Still another important activity of the Aeronautic Development Service is the preparation of maps and charts for air navigation. The maps compiled are published on a scale of 1 to 500,000, or about eight miles to the inch. The maps published to date, usually referred to as "strip maps," cover strips eighty miles in width and from two hundred to four hundred miles in length—the size of each sheet being eleven inches wide and twenty-four to forty-eight inches long, a

very convenient form and size which can be readily folded for use by the pilot. This section has recently started work on the publication of a series of sectional area air navigation charts covering the entire United States.

The material used in the compilation of the air navigation maps is taken from various sources. Among these are the topographic maps of the U. S. Geological Survey; the contour lines forming the boundaries for gradients of elevation on airways maps are almost always taken from these topographic maps.

After an air map compilation has been made from the best available material, photographic copies mounted on cloth are flight checked. This work is done by a trained engineer who goes as an observer with a pilot of the Aeronautics Branch. A number of trips are made back and forth across the region represented until the whole area is covered. The compilation is then corrected accordingly and lithographic impressions are made on a scale one fourth larger than the compilation. One of these sheets is inked for each color to be printed on the map. When the inking is finished, the drawings are again reduced by photography to the original scale and the negatives are used to prepare the aluminum plates for printing the edition. The maps are printed in color to express such various features as streams, elevations, airports, flight courses and magnetic variations.

The Aeronautics Branch has organized a number of special research committees under the chairmanship of the director of aeronautic development for the purpose of investigating certain problems as follows:

The fact-finding committee organized to determine the effectiveness of the automatic application of water in controlling airplane hangar fires has just completed an extensive series of fire tests and is now engaged in the preparation of its report.

The committee on standard signal systems for airports is conducting studies looking toward the development of standard signal systems, suitable for both day and night use, for controlling traffic on and in the vicinity of airports and for communicating special information to pilots.

The liaison committee on aeronautic radio research has made a survey of aeronautic radio research now in progress and of those radio problems the solution of which will assist in bringing about the highest degree of safety and reliability in air transportation. This committee has just submitted its first report to the Assistant Secretary of Commerce for Aeronautics.

The committee on airport zoning and eminent domain is making a study of those problems having to do with the protection of the flying public against hazards that might be developed in the vicinity of airports.

The committee on airport drainage and surfacing is studying the problems involved in airport drainage and surfacing, and collecting and correlating available data and experience with the object of presenting a report that will serve as a working-tool in the hands of engineers engaged in the development of air terminals.

As the point of contact between the Aeronautics Branch, the aeronautic industry and the general public, the Aeronautic Development Service is charged with most of the promotional duties covered by the Air Commerce Act of 1926. Specifically, these duties include the preparation and publication of the *Air Commerce Bulletin*, a semi-monthly periodical, and more than a score of permanent aeronautic publications on important phases of aeronautics, the collection and dissemination of information pertaining to civil aeronautics, the preparation and publication of airway bulletins, the compilation of statistics regarding the manufacture and operation of civil aircraft, including accidents, and the maintenance of an aeronautics reference library.

The *Air Commerce Bulletin* is sent to more than 12,000 readers who have specifically requested it. This bulletin is also circulated through aeronautical clubs, libraries, airports and other seats of flying activities. Among other things, it carries official notes to pilots, manu-

facturers and operators of aircraft; information pertaining to new regulations and air traffic rules; statistics on operation, miles flown, accidents and their causes; lists of aeronautical lights certified; general notes on the progress of civil aeronautics at home and abroad; lists of air routes in operation; notes on the progress of airway lighting, radio and other aids to air navigation; articles and tabulations on airport and airway development; state laws and municipal ordinances; existing and proposed airports; lists of official publications available, and other constructive information of an authentic and authoritative nature relating to civil and commercial aeronautics.

In connection with this phase of its activities, the Aeronautic Development Service procures, compiles and analyzes all statistical data for the Aeronautics Branch—including data covering aircraft production, aircraft operation, aircraft accidents and aids to air navigation; collects facts and figures for all statistical bulletins of the Aeronautics Branch, including the Aeronautics Trade Directory; distributes all publications and printed forms of the Aeronautics Branch; interviews persons desiring general information, and handles correspondence that does not pertain to the technical phases of the work of the Aeronautics Branch.

Of steadily increasing importance is the work of preparing and issuing airways bulletins containing descriptions of airports and information regarding other air navigation facilities in the United States. These bulletins, which are distributed to a mailing list of approximately 3,000 individuals and organizations, are illustrated loose-leaf sheets describing airports, Department of Commerce intermediate fields, airways, air markings, meteorological conditions and other data essential to air navigation. The bulletins describing airports carry in each case two maps, one of the airport itself showing the immediately surrounding terrain, and the other showing the airport's location with respect to nearby railroads, rivers and the nearest city. In addition, these bulletins give the name of the airport, its class, latitude and longitude, altitude above sea-level, description of surface and runways, obstructions, marking and identification, lighting, accommodations, meteorological data and other information desired by pilots or operators. To date, 983 airways bulletins have been issued.

The Aeronautics Reference Library of the Aeronautics Branch is also a part of the Aeronautic Development Service. On file in this library there are now 471 bound volumes and more than 10,000 domestic and foreign magazine articles, pamphlets and reports which have been catalogued for ready reference. Complete sets of all government aeronautical publications as well as an extensive file of news clippings are maintained. A semi-monthly bulletin is published listing references of important articles indexed by the librarian from current publications received. Close cooperation is maintained with the engineering and technical units in the collection of data on the latest engineering developments.

The program of aeronautic development now being carried out by the Aeronautics Branch is the result of a careful study of the more important phases of aeronautics that are in need of immediate attention. As the aeronautic development work of the Aeronautics Branch goes forward from day to day, and as problems of the moment are disposed of, new ones arise to take their place. The Aeronautics Branch is aware of its obligations under the Air Commerce Act and is endeavoring to discharge them to the complete satisfaction of the public.

AIR REGULATION

By GILBERT G. BUDWIG

DIRECTOR OF AIR REGULATION DEPARTMENT OF COMMERCE

THE Air Commerce Act of 1926 charges the Secretary of Commerce with the promotion of civil aeronautics, and also with its regulation.

Prior to the passage of this act, aeronautics regulated itself. This meant that the judgment of the pilot and mechanic was the law of the moment. As aeronautics continued to grow and as its value in the field of transportation became more and more evident, Congress, in 1926, felt the time had arrived for a standardization and uniformity of operation of aircraft and airmen.

Accordingly it granted the regulatory powers to the Secretary of Commerce. The spirit of these regulatory powers may be set forth in a few words, "airworthy aircraft operated by competent airmen." From this initial starting-point, two courses were laid out for the realization of this valuable motto for the development of aeronautics.

They were licensed aircraft and licensed airmen. Both are accomplished through initial and periodic examinations. The first examination determines the qualifications of the applicant, be it aircraft or airman, while the succeeding ones determine the right of the license holder to continue in good standing.

The license for both airman and aircraft places a federal stamp of approval on the holders. The license gives testimony to the fact that a number of rigid requirements have been met to the satisfaction of the Department of Commerce, and as long as the holder of the license continues to observe these requirements he will continue to receive the endorsement of the department.

The regulations require that all aircraft and airmen engaged in interstate commerce shall hold a Department of Commerce license. Originally this provision opened the door for the operation intrastate of aircraft and airmen who could not qualify for a federal license. The government has no jurisdiction over aircraft activities within a state as long as they remain within that state's borders. The moment an unlicensed pilot or plane, engaged in commerce, crosses the border in pursuit of that commercial venture, he becomes subject to the federal law.

Many states, recognizing that aircraft and airmen who can not meet the requirements of the Department of Commerce for licenses are endangering their own lives and those of the innocent public, have adopted laws requiring aircraft and airmen to hold the Department of Commerce licenses regardless of whether they engage in commercial ventures within the state or interstate. Thus the day of the unlicensed pilot and plane is on the wane.

Prior to the Air Commerce Act of 1926, there were many ideas current as to how aircraft should be built. As there was no supervision over the design and construction of these aircraft, as there were no recognized standards followed in all cases, the task of licensing aircraft as being airworthy was exceedingly difficult.

In an effort to save the time and money of the manufacturers as well as to protect the public against aircraft designed and built contrary to the generally recognized sound methods then in existence, the Department of Commerce, with the cooperation of the industry, drew up certain engineering requirements to be met before a plane could be

produced in quantities for use in interstate commerce.

These standards now are observed by all aircraft manufacturers seeking approved type certificates for their products. Once the certificate is granted, the manufacturer may build unlimited numbers of these craft subject to supervision during their construction period and flight testing after their completion by inspectors of the Aeronautics Branch. These types are then eligible for license.

In this way, aircraft designed by persons with a smattering of aeronautical engineering knowledge or no knowledge at all, and aircraft constructed in a woodshed with a saw and hatchet, are discouraged and have been discouraged to such an extent that they now are a memory of the pioneering days.

As for the airman, experience has developed the system of licensing in use to-day which is serving the needs of aeronautics to the best advantage. A person desiring to become a pilot first must obtain a student permit which is issued by the authorized Department of Commerce medical examiner if the applicant satisfactorily passes the required physical examination.

His student days over, the applicant takes his examination for the private pilot license, which includes a rigid written as well as flying test. The holder of a private pilot license is not permitted to engage in interstate air commerce.

To the private pilot there are available higher grades of licenses—limited commercial, industrial and finally the transport pilot license. The limited commercial and industrial licenses involve certain restrictions as to carrying passengers, but the transport pilot license permits the holder to fly any type of licensed plane and to carry passengers in any plane that he has demonstrated his ability to operate before a Department of Commerce inspector.

From the beginning of its regulatory activities, the Department of Commerce made plans leading to airworthy aircraft from their inception. No authority existed under the act to follow the same course with respect to the pilot. It was not until early last year that such authority became available through an amendment to the act which gave the Secretary of Commerce authority to approve flying schools as to the adequacy of the course of instruction, the suitability and airworthiness of the equipment and the competency of the instructors. Examinations and inspections leading up to approved flying schools are made only upon the application of the institution.

There now are more than two score approved flying schools in the United States that have been examined and constantly are the subject of federal inspection with the view to seeing that they continue to adhere to the minimum requirements established by the department for approved schools. Among these requirements are the provisions that instructors must hold a special license as flying and (or) ground instructors. Pilots giving instructions at schools not approved are required to hold the transport license.

Thus the department has been able, in a great measure, to assist in bringing about the airworthiness of aircraft and the competency of airmen from their inception. As aeronautics progresses, this phase should develop to a point where there will be uniformity and standardization of the development of aircraft and airmen in conformity with the best and time-tested standards.

An important feature of the airworthiness of aircraft is its engine. The Aeronautics Branch requires that all airplanes engaged in interstate commerce shall be equipped with power plants of a type bearing federal approval. The engines for aircraft use, therefore, must pass type tests as to reliability pre-

scribed either by the Department of Commerce or by the Army or Navy before they can be certified.

Some of the other phases of air regulation are:

The examination and licensing of mechanics
The transfer of title to aircraft assigned Department of Commerce markings
The issuance of certificates of airworthiness for export to aircraft to be exported to foreign countries having reciprocal agreements with the United States
The validation of such certificates and the maintenance of all files and records pertaining thereto
The handling of legal phases of enforcement of the Air Commerce Regulations
The enforcement of violations of the Air Commerce Act, the Air Commerce Regulations and the Air Traffic Rules
The assessment of penalties thereunder
The determination of the causes of civil aircraft accidents

An indication of the volume of work in air regulations may be gained from the fact that during the past fiscal year which ended June 30, 1930, a total of 64,806 licenses, license renewals, title transfers, export certificates, identifications and student permits were issued as against 42,408 for the previous year. This represents an increase in volume of work over the preceding year of 153 per cent.

During this same period, pilot licenses renewed increased 195 per cent. over the year before; pilot licenses issued, 197 per cent.; student permits issued, 133 per cent.; aircraft licenses issued, 145 per cent.; aircraft licenses renewed, 309 per cent.; transfers of title completed, 147 per cent.; export certificates issued, 114 per cent.; identification marks assigned, 100 per cent.; mechanics licensed, 113 per cent.; mechanics licenses renewed, 2,909 per cent.

The Aeronautics Branch has just taken what is regarded as the most important step since it undertook the licensing of aircraft and airmen. Reference is made to the new regulations governing the operation of scheduled interstate air passenger services, which became effective May 15. The fundamental requirements of these new regulations are as follows:

AIR COMMERCE REGULATIONS GOVERNING SCHEDULED OPERATION OF INTERSTATE PASSENGER AIR TRANSPORT SERVICES

1. *Law of, scheduled operation of interstate passenger air transport services.*

   The Secretary of Commerce shall by regulation . . . provide for the issuance and expiration, and for the suspension and revocation, of registration, aircraft and airman certificates, and such other certificates as the Secretary of Commerce deems necessary in administering the functions vested in him under this act. (Sec. 3 (f).)

2. *Application of the law.*

   For the purpose of conducting the scheduled operation of passenger air transport services in interstate air commerce, as defined by the Air Commerce Act of 1926, it shall be necessary for any person, firm, copartnership or corporation to obtain from the Secretary of Commerce a certificate of authority to operate such service.

3. *Issuance of certificate.*

   Before such a certificate of authority will be issued by the Secretary of Commerce, application therefor shall be made by the person, firm, copartnership or corporation proposing to conduct or to continue the class of service covered by section 2. The application shall be made in such manner as the secretary may prescribe. This certificate, if issued, shall be conditioned upon compliance with the Air Commerce Act, and the Air Commerce Regulations, including the specific requirements set forth herein.

4. *Aircraft and airmen.*

   (*a*) Aircraft shall be provided with suitable instruments and equipment and shall be properly adaptable to the nature of the service involved, and to the conditions attendant thereon.

   (*b*) An adequate number of qualified airmen shall be employed who shall be fully competent in all phases of the particular operation, including the use of equipment, devices, accessories, and other aids incident to the operation for which the

certificate is issued. The Secretary of Commerce may, in his discretion, require that the crews of the aircraft employed shall include such qualified personnel, other than the pilots in command, as may be necessary safely to carry out the particular operation.

5. *Maintenance of equipment.*

All aircraft, including engines and equipment, shall be maintained to the highest degree of operating efficiency, and to this end certain fixed periods will be determined by the Secretary of Commerce for the inspection, repair and overhaul of aircraft, engines, instruments and equipment.

6. *Airways and air navigation facilities.*

All airways or routes over which scheduled operations are conducted or proposed shall be provided with such air navigation facilities as are considered necessary by the Secretary of Commerce in the interest of safe and reliable operation of the particular service involved or to be undertaken.

7. *Ground organization.*

The operator shall provide to the satisfaction of the Secretary of Commerce an adequate and properly qualified ground organization to administer efficiently all phases of the ground operation, including maintenance.

8. *Flight clearance.*

Each scheduled flight shall be authorized, delayed, suspended or canceled by competent officials designated by the holder of the certificate of authority. The manner and form in which this is accomplished will be prescribed by the Secretary of Commerce.

9. *Operations instructions.*

The Secretary of Commerce may from time to time prescribe uniform instructions pertaining to operations, the issuance and publication of which by the holder of the certificate of authority shall be mandatory, and such instructions shall be made conveniently available for the information of all passengers in the manner and form prescribed by the Secretary of Commerce.

10. *Ground for revocation or suspension of certificate.*

The certificate of authority may be suspended or revoked for:

(*a*) Violating the Air Commerce Act or the Air Commerce Regulations, including the specific requirements set forth herein.

(*b*) Failure to make any proper and seasonable report which may be required by the Secretary of Commerce.

(*c*) Making false statement in application, or information accompanying the application for said certificate, or in any report required by the Secretary of Commerce.

(*d*) Conducting operations contrary to the public safety and interest.

(*e*) Using or displaying said certificate for fraudulent purpose.

11. *Savings clause.*

These regulations shall take effect midnight May 15, 1930. Air transport services subject to these regulations may continue to operate until midnight, July 15, 1930, on or before which date said air transport services shall file an application for a certificate of authority with the Secretary of Commerce. Upon receipt of said application, the Secretary of Commerce may issue a temporary letter of authority to operate, pending inspection, in the manner and form prescribed by said secretary.

CLARENCE M. YOUNG,
Acting Secretary of Commerce

Approved May 2, 1930.

Obviously, they require interpretation and detailed interpretations now are being prepared. When placed in full operation, the requirements are expected to bring about even higher records for safety and reliability of scheduled passenger air transport.

The Aeronautics Branch found this action necessary in order to standardize the various ideas of air transportation that develop from time to time. There will be conservative operators, liberal operators and operators not aware of the details necessary to make for safe and reliable service. The standard of minimum requirements adhered to will give air transportation the same uniformity of operation as is now enjoyed by the major railroad and steamship lines.

NATURE VERSUS NURTURE IN THE DEVELOPMENT OF THE MIND

By Professor S. J. HOLMES
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ONE meets more or less frequently with expressions of the opinion that recent investigations in psychology have demonstrated the overwhelming importance of environment as compared with heredity in the development of the mind. There is perhaps no subject of more vital concern to the eugenist than the heredity of mental traits. If the mental differences among human beings are almost entirely the result of varied conditions of life, the worries of the eugenist over the super-fecundity of the subnormals and the low birth-rate of the intellectuals would really have no adequate foundation. Many people would like to believe that this is true, for if it is true we may console ourselves that the most serious of our so-called dysgenic ills will gradually recede before the triumphant march of social reform.

That there is still a remarkable amount of divergence of opinion over the relative importance of nature and nurture in the development of mental traits is doubtless due in large measure to the fact that mental traits are demonstrably influenced by both hereditary and environmental factors, and that our problem is one of the relative influence of two forces, always intimately associated, neither of which is capable of very precise measurement. Another potent cause of disagreement is the fact that a considerable number of those concerned with psychology, education and the social sciences have a very imperfect grounding in the principles of modern genetics. Then we have various kinds of emotional bias which influence opinions on the subject to a marked degree. There is the theological bias which leads people to regard with disfavor the doctrine that traits of the mind obey the same laws of heredity that obtain for the material body. A probably stronger bias in these days arises from the varieties of political and social philosophy whose votaries scent a danger in the doctrine of the natural inequality of man. We have also what may be called the humanitarian bias, commonly found among those engaged in the uplift of their fellow creatures, which predisposes people to attribute human ills, so far as possible, to remediable causes. The so-called fatalistic teaching of the hereditarians is regarded as a sort of challenge to the efficacy of their efforts at social improvement.

As a result of many kinds of bias, complexes, phobias and idola we have a large body of interested and often aggressively good people who are eager to welcome anything which seems to weaken the position of the hereditarians. Recent investigations have supplied a large amount of material bearing upon the question at issue. Not only have many contributions been made by the biologists, but a large number of researches are described in the rapidly swelling literature on educational psychology.

As a preliminary to the discussion of these results it may be desirable to trace briefly the development of our topic. The first substantial contribution to our knowledge of the inheritance of mental ability was Francis Galton's well-known book on "Hereditary Genius." By the use of impartial statistical methods,

Galton conclusively proved that superior mental ability runs in families, and that the more eminent a person is the greater the number of eminent relatives who will on the average be found in his family. Further evidence in support of this general conclusion was furnished in his book on "English Men of Science" and in a work by himself and Schuster on "Noteworthy Families" based on a study of the family histories of fellows of the Royal Society.

The work of F. A. Woods on "Heredity in Royalty" showed that in the favorable surroundings of royalty there are differences in the mental abilities of families which are very much like those which occur in the general population. Parent-offspring and fraternal correlations were discovered by Pearson and his coworkers, who found a close resemblance in scholastic records between parents and offspring and between children in the same family. These correlations were roughly about the same as those for various physical traits, which average about 0.5. It was contended by Pearson that since mental traits run in families to about the same degree as traits such as eye color and cephalic index, which are admittedly little affected by environment, we must conclude that it is heredity which affords the explanation of all these cases of familial transmission. When abilities came to be measured by mental tests as well as scholastic records very similar parent-offspring and fraternal correlations were reported by a number of investigators.

In the light of a large body of knowledge which is now accumulated, no one with the least knowledge of the facts can deny that mental ability, as gauged by available methods, shows a strong tendency to run in families. The environmentalists maintain that this tendency is no proof of the inheritance of mental traits; the relation can as well if not better be explained as the effect of the social, educational and other advantages which fall to the lot of the children of more distinguished parents. There is no doubt that in most cases circumstances favorable for education, if not mental development, are more frequently found in families with a tradition of culture. It is very pertinent to inquire, therefore, whether or not these influences can account for the whole of the resemblance between parents and offspring in respect to intelligence and other functions of the mind. Here is a problem of the relative influence of two factors each of which is capable of accounting for variations in mental development. Consider, for instance, the Edwards family, which has been so much discussed in connection with our present problem. The descendants of Jonathan Edwards include a surprising number of people who have acquired a high reputation for intellectual achievement. But the children in these families had the advantage of good schooling, a stimulating home environment and a certain amount of social prestige which aided them in attaining worldly success. Would the families of their undistinguished neighbors have made the same reputation under just the same conditions? From what one knows of heredity and the influence of environment one might judge they would not, but there is no way in which the effects of heredity and environment can be separated in such a case in any clean-cut way. Parent-offspring or fraternal correlations can not be taken as a measure of the extent of hereditary resemblance without begging the question at issue. All that such correlations prove is the fact of familial resemblance, and they prove nothing directly as to the cause of this resemblance. We do not doubt the correctness of the genetic explanation in the case of eye color or polydactylism because there are no traditional environmental influences which would tend to cause this relationship. But when it

comes to mental development we are in a different position. Our means of measuring heredity fail us, for whenever we say that a given difference in mentality is due to heredity the environmentalist may challenge our statement and claim that it may be due to environment, or at least that we can not prove that it is not. And if one is under the influence of any of the several kinds of bias to which I have alluded he can still cling to his interpretation and defend it by arguments, however unconvincing these may be to the hereditarian. Several writers who have touched upon this theme consider that we have arrived at an *impasse*, and regard the solution of the problem as practically hopeless. The situation is, I believe, far from being as bad as this, and, unless I am greatly deceived, is showing distinct signs of clearing up. But it should be stated that there is not entire agreement as to which position is being strengthened by the results of recent investigations.

In a recent book on "The Behavior of Young Children of the Same Family" Miss Weill informs us that

> Scientific thought wheeled from an environmentalist point of view during the latter half of the nineteenth century, to a hereditarian and more fatalistic one, until the convergence of laboratory experiment, investigation of the causes of criminality, behaviorism, psychoanalysis, sociology, endocrinology, mental hygiene and child psychology showed that the springs of conduct lie in the early years of childhood, especially in the preschool period, and that environmental forces acting on this plastic material are able to mold it practically at will.

Miss Weill's book is based on several cases of problem children coming before the Habit Clinic of the Massachusetts State Division of Child Hygiene. When the environment of children living in the same family was investigated it was found that what superficially might seem to be the same surroundings for all the children was really far from being so. Differences of age, attitudes of parents and other children and many other factors create varied influences which, in the opinion of the writer, adequately account for the pronounced differences often manifested by the children of the same family. It is not denied that in certain cases hereditary factors play an important rôle, but the effort is made to explain everything in terms of environment wherever possible. In the case of the Sadnow family, for instance, it was pointed out that varied ages and interests keep each child in a different environment, and that in the case of the aberrant member, Micha, who it seems was very much of a spoiled child, "the environmental differences here are so strong that they may well be considered the cause of his behavior anomalies, and of the difference of his reaction to the family situation." An improved régime together with some wise counsel as regards discipline was said to have conduced considerably towards making Micha a better boy. Let us hope so. But even if Micha should turn out to be a most exemplary person, we are by no means justified in ruling out a possibly important influence of heredity. Where we are dealing with modes of response which can be readily conditioned even at an early age the separation of hereditary differences in appetites, aversions and other fundamental drives from the varied effects of early training is a matter of much difficulty. A study of the differences in disposition between identical and fraternal twins affords some interesting material in this connection, but the environmentalist may contend that ordinary, or fraternal, twins by virtue of their differences soon get into different relations with their environment and come to experience very unlike reactions from their associates.

In the study of problem children to which I have referred it is stated, apparently without sufficient appreciation of its bearing on the problem, that the parents of these children showed a large amount of neurotic disorder. "The large majority of the cases, however, thirteen of the seventeen, come under the classification of mental disability. Of these thirteen, one case shows stupid parents; one case a bad-tempered father and a yielding mother, and eleven, neuroticism in one or both parents."

Under such conditions one would expect to find as a result of Mendelian segregation a good deal of hereditary variability in dispositional traits among the offspring, and much of the kind of heredity which would predispose children for candidacy in a habit clinic. Environmental factors were doubtless varied and often unfavorable for the unfortunate children who were investigated. But under the circumstances, to claim that the results described demonstrate the overwhelming influence of environment as compared with heredity is quite unwarranted.

Perhaps the most extreme environmentalist position is occupied by Dr. J. B. Watson. This writer gravely informs us that "there is no such thing as an inheritance of capacity, talent, temperament, mental constitution and characteristics. These things again depend on training that goes on mainly in the cradle." We only inherit structures. "Habit formation starts in all probability in embryonic life and that even in the human young, environment shapes behavior so quickly that all the older ideas about what types of behavior are inherited and what learned break down." Dr. Watson, whose conception of heredity seems to be very different from that of the modern geneticist, is led to adopt a position which is open to all the objections which have been urged against the discarded teachings of Locke. For him the mind is a *tabula rasa* upon which experience writes all the contents. Barring certain obvious differences in physique all babies are supposed to be practically alike—all of them are plastic material which the skilful manipulator can mold into any form that is desired. Every one knows that young children readily acquire habits good and bad and that they can be inspired with fears and phobias in regard to many objects, but if Dr. Watson were able to demonstrate that he can alter the intelligence quotient of a child as little as twenty points there would be more basis for his extravagant claims. Even very young babies acquire conditioned responses and soon learn to tyrannize over their mothers and nurses. As a result of studies on early infancy we are acquiring much more accurate knowledge of the effects of experience in molding the character and disposition of children. But so far as I can discern, we have learned nothing which, in principle, was not familiar to our grandmothers. And if our grandmothers had told us that because it is quite easy to spoil children therefore there is nothing in mental heredity, their argument would have precisely as much cogency as that of Dr. Watson.

In the field of emotional reaction, habit formation and the development of principles of conduct the potency of environmental influence has been recognized for centuries, and I am not aware that it has ever been denied. Yet we know little of the extent to which affection, for instance, can be cultivated or suppressed, or, barring ill health, how far the disposition or temper of an individual may be changed under varied external conditions. We observe marked differences in temper and disposition appearing among members of the same family even from an early period, and under conditions which point strongly to initial differences in hereditary make-up. The environmentalists

always have some sort of an explanation to fall back upon, however far-fetched it may appear. Their argument takes this general form. Since grandmother spoiled Johnny by giving him whatever he wanted whenever he cried, how do you know that the very different traits of Mary and Lucy might not have had their cause in some early experience which produced a profound effect at a particularly impressionable period of their lives? Not knowing all the events in the history of each girl or just how each was affected by all her varied experiences, one is naturally unable to satisfy the environmentalist on this point.

The environmentalist argument is very much like that of a gardener who would claim that since soil and cultivation make such striking differences in the growth of plants, the matter of possible differences in seed can safely be ignored. In the development of character traits cultivation, as in plants, produces its obvious results, but our measures of the effects produced are so inexact and our means of comparing the relative influence of heredity and environment are so imperfect that no very definite conclusions can at present be drawn.

When we are dealing with the development of intelligence, however, we are in a better position. All the studies on the inheritance of intelligence are based on the assumption that we are concerned with something whose differences can be measured and compared. Galton made achievement and reputation a basis for a rough gradation of degrees of mental development. In other studies scholastic records or teachers' estimates of intellect were employed, and in recent studies use is commonly made of the intelligence quotient, or ratio of mental age to chronological age which is given a definite numerical expression. Every one admits that measures of intelligence are not always exact. Doubtless intelligence itself varies with the state of health, the emotional attitude and many other influences which fluctuate from day to day and from hour to hour. But nevertheless intelligence, however we may define it, is something which can be measured with a fair degree of accuracy.

One very striking finding of the numerous investigations on mental measurement is that there is a fairly definite limit to the growth of intelligence at from sixteen to eighteen years. Let us consider the meaning of this simple fact. If experience alone is responsible for the growth of intelligence there seems to be no reason why intelligence should not continue to grow as experiences accumulate throughout the greater part of life. The course of mental growth, like the course of physical growth which it so closely accompanies, must, therefore, be largely determined by internal causes. We may check or accelerate our physical growth in a number of ways, but except in extreme cases the changes produced are relatively slight. We can not make a man stop growing at ten or keep him growing until he is seventy. (I am disregarding here the accumulation of fat, which has its psychical counterpart in the accumulation of mere information.) One may keep on growing in knowledge or even in wisdom, but intelligence has pretty definite limits which are practically unchangeable. This fact does not harmonize at all with the doctrine that intelligence is not inborn but created as the result of experience.

Another highly significant result of mental testing is the fact that intelligence not only varies enormously among individuals, but the intelligence quotient is fairly constant in a given individual during successive years. The constancy of the IQ obtains for all degrees of intelligence from that of the feeble-minded to that of the very superior child with a grade of 140. Minogue found that among 441 feeble-

minded children who gave a very low initial rating, 71.7 per cent., tested from two to ten years later, varied less than 5 points; 91 per cent., less than 10 points, and that there was rather more of a tendency to deteriorate than to gain in intelligence scores, 4.8 per cent. showing a gain and 23.6 per cent. a loss. A similar tendency has been found in 200 cases by Bonnis.

Miss Otis has endeavored to improve the intelligence of feeble-minded girls over sixteen and found that the scores were raised somewhat "due more to changes in vocabulary score and understanding than to change in memory span or reasoning ability. . . . The gain in the reasoning tests could not be estimated, for there is hardly any success in these reasoning tests for any of the forty girls. . . . If the reasoning ability is absent there seems to be no way of training it in."

Turning to individuals of superior intelligence we find that, as a rule, a high IQ is manifested early in life and is consistently maintained at a high level. In a report of a follow-up study of a group of seventy-three children having an IQ of 136 or more in 1921–22, Duff found that, as compared with a group of controls with an average IQ of 100, the highly intelligent children were doing very creditable work; a larger percentage than the controls went to secondary schools, and 55 per cent. won prizes in the secondary schools, while no prize fell to the lot of the controls except one for attendance. Since some of the control group went on to secondary schools while some of the intelligent students did not it is of interest to compare these two classes. The intelligent group who were not in secondary schools were superior to the controls who were in these schools in spelling, adequacy of expression, quality and quantity of reading and in ambition. Of the control group none passed the school certificate, and only one reached the stage of attempting it. Of the intelligent group in secondary schools thirty passed the certificate and seven failed; ten changed schools; two were too young to try the examination, and two were lost from the record.

One of the most extensive investigations of superior children is that carried on by Dr. Terman and his associates on one thousand gifted children in California schools. The selection was made on the basis of intelligence scores of 140 or higher, a grade attained by less than one half of 1 per cent. of the school population. As a rule these superior children were of good vitality, interested in sports, socially adaptable and quite far from being the one-sided freaks that children of superior mentality are often supposed to be. Their ability was general rather than special, and their superiority was manifested in most cases in the preschool age. In school they had no advantages over the rank and file. In fact they received less attention than the dullards, as superior children generally do. They were helped a little more at home and in some cases they received a little more instruction than the ordinary child in preschool years, but there was nothing in their home environment which gave any adequate explanation of their superiority in mental tests. Information collected two years later showed that these children still possessed a marked superiority over their fellows. Whatever formed the basis of the higher attainments of these children was a persistent characteristic which manifested itself from an early period and behaved very much like an inherited trait.

It might be claimed that environment produced its effects upon these children while they were very young, for there has come to be a tendency to emphasize the cradle experiences of children as powerful factors in their future career. But whether it was the quality of milk

they received, the amount of orange juice or the patterns of the wall-paper they gazed at which exercised so marvelous an influence upon the development of their minds must be left to the environmentalists to ascertain. Here we need the illuminating wisdom of Dr. Watson.

But how about ancestry? To a large extent the fathers of these thousand gifted children were found to follow pursuits which required more than the average mental ability. Relatively the largest proportion of the fathers came from the professional classes. A considerable number were business men. A smaller number were skilled artisans, while less than 1 per cent. were unskilled laborers. In the pedigrees of these children there were many noteworthy names in English and American history, and the surprising fact was revealed that nearly one fourth of the individuals in the Hall of Fame were found in the ancestry of this group.

Evidence of the strong influence of heredity is also furnished by Cobb and Hollingworth's studies of the siblings of children testing from 135 to 190, with an average of 154. The average grade of the siblings was 129, and their tests ranged from 96 to 173. The siblings of children testing over 150 averaged 132.8, while the siblings of those testing from 135 to 150 averaged 124. Thirty cousins gave an average score of 127.

Correlative to the preceding studies of gifted children we have the interesting investigations of Cox, who, starting with adults who had achieved greatness, endeavored to ascertain from what kind of children these geniuses developed. From a variety of biographical sources an effort was made to gauge the IQ of these children. However successful this effort may have been—and the figures should be regarded only as a rude approximation—the striking fact is clear that great men come predominantly from children who from an early period manifested unmistakable signs of superior intelligence. Great men do *not* come from dull boys. We may generalize the results of researches on the constancy of the IQ by saying once stupid always stupid; once intelligent always intelligent. If the environmentalists could show that nurture is capable of developing intelligence to the extent of converting an individual with an IQ of 80 into one with 140 and that such transformations were matters of common occurrence he would have a fair basis for the contention that education and opportunity can account for the whole resemblance that is found among members of the same family. But even then his case would not be demonstrated. I might show that the proper cultivation can make very great changes in the growth of peas, but this would not exclude the possibility of my having the seeds of both tall and dwarf varieties in my stock. In the field of intellectual development, however, it has not been shown that much change is even possible. It is doubtful that if the intelligence of an individual is fairly tested it can be raised as much as twenty points. If good intelligence does not come by the grace of heredity there is no way in which it can be made.

Evidence supporting this conclusion is coming in from a variety of sources. Through studies made on groups of children under comparable conditions it has been shown that similarity of treatment does not reduce original dissimilarities, and that giving all students the best possible means of developing their capacity tends rather to increase than to diminish their differences in achievement. Some interesting work has been done with foster children who were adopted before they were one year of age. The intelligence of these children was found to resemble that of their real parents whom they had scarcely seen much more than

that of their foster parents with whom they were continually in contact. Those children who were adopted in better homes gave somewhat higher intelligence scores, and since with children adopted at so early an age there was probably little or no selective placement this improvement may fairly be attributed to environment.

Interesting side-lights upon the problem of nature and nurture have been furnished by studies on the mental resemblance of identical and ordinary, or fraternal, twins. Identical twins are in all probability derived from a single fertilized egg and hence have an identical heredity. So far as they have been studied the intelligence scores of identical twins show a remarkable degree of similarity, although there seems to be a wider divergence in character traits and disposition.

It is not improbable that different mental traits, like different physical traits, are very unequally affected by surrounding conditions. Environment may change the color of one's skin several times as much as the color of one's eyes. It may affect sweetness of disposition and adherence to moral standards of conduct much more than the power of abstract reasoning. In the field of the affective life environment may be more potent than in the development of the intellect. But our means of measuring affective states and reactions are very imperfect, and any really scientific treatment of the relative influence of these two factors is as yet impossible. Where the influence of the environment can be measured with some crude approach to accuracy its limitations are becoming more apparent as knowledge advances.

ACTIVITIES OF THE CALIFORNIA WOODPECKER

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In previous publications[1] I have dwelt in considerable detail on the surprising way (surprising as judged by commonly held notions about instinct and intelligence) these birds do things greatly to their advantage at times and quite the opposite of this at other times. For instance, I have shown that almost certainly their storing of acorns for food gives them a distinct advantage in several ways over other species of woodpecker that have not acquired a method of providing themselves with a food supply that is anything like as ample, as certain and as easily available as is this. The general adaptiveness of the activity is unmistakable.

What, then, can be said about their storing pebbles and other useless objects, which they do to a very considerable extent, except that this activity is not adaptive, or is maladaptive?

While on a woodpeckering expedition in June, this year, along what the local residents fondly call the "Bret Harte-Mark Twain Trail" of California's famous old mining region, I came upon several instances that well illustrate this contradictoriness. Two of these, one for each side of the balance sheet, I will now present briefly. Let us take the adaptive instance first.

About eight miles from Grass Valley on the road to Marysville is a relatively level area (the whole region is in the foothills of the Sierra Nevada Mountains) of perhaps four square miles, known as Mooney Flat. Scattered over this area and widely spaced are many old and very large valley oaks (*Q. lobata*). Live-oaks, probably the interior live-oak (*Q. Wislizenii*), and a sprinkling of blue oaks (*Q. Douglasii*) are also seen here and there. There are too a considerable number of digger pines (*P. Sabiniana*) and a few yellow pines (*P. ponderosa*). Around some of the farmhouses are a few large cottonwoods. To any one acquainted with the habits of the California woodpecker, this description of Mooney Flat is equivalent to saying that it is an ideal place for the species. As a matter of fact it contains a rather specially populous "settlement," as I have designated such localized and well-established groups of the birds.

The particular point to be made here concerns the nesting and residential holes more than the pits for acorn-storing.

I have previously called attention to the fact that these holes are almost but not quite always placed on the under sides of large, living branches of oaks, if, as is very common, oaks are used for this purpose. This location secures a large measure of protection against storms of rain, snow (in the mountains) and winds. Mooney Flat, like most such areas in California, is crossed in various directions by roads along which run electric wire lines and wire fences, the posts of which are of cedar, redwood or some other moderately soft wood. In such places the woodpeckers are inclined to transfer their

[1] *E.g.*, "The Nutritial Activities of the California Woodpecker (*Balanosphyra formicivora*)," *Quarterly Review of Biology*, 4: 455–483, December, 1929.

acorn-storing and home-making activities from trees to wire line poles and fence posts. Nowhere have I seen this transfer carried farther than on Mooney Flat. On one consecutive string of twenty-six poles, sixteen contained habitation holes, the number in each pole varying from one to twelve.

Now when trees are used for the holes the more or less horizontal position of the branches makes the placing of the holes for protection from storms quite easy. But what about such protection when the poles are used, these being typically straight up and down, and, of course, without branches? This natural query troubled me considerably for some time, and as a sort of answer I set up the counter question as to whether the birds really do use poles for nesting.

But this question was easily and conclusively answered. Pole holes are used, and in some localities are much used, for nests and other residential purposes. Does this mean that protection against storms is ignored in such cases? Quite accidentally at first I noticed here on Mooney Flat that several nest holes were on the north side of the poles which here were sawed with four flat equal faces. This fact noticed, and it being recalled that here, probably, as nearly everywhere in California, almost all the storms come from the south, systematic attention to the location of the holes easily settled the matter. Of a total of 131 holes in 35 poles, 92 were on the north faces and 7 on the south faces. There were 25 on west faces and 7 on east faces. This is not quite accurate, as it makes no allowance for the fact that the faces of the poles did not quite correspond in all cases with cardinal points of the compass. But since the observations were made at noon on a perfectly clear day so directions were easily determined, the small errors on this score could not materially affect the general result. It may be mentioned that the acorn-storing in these poles corresponded as to distribution pretty well with that of the nest holes; but with this we are not here concerned.

Here, then, seems to be a perfectly clear case of an action that is adaptive in a high degree. It is hardly open to doubt that the nesting and residential holes are better placed for the good of the birds, old and young, on the north than on the south sides of the poles. Furthermore, wire line poles have come into the environment of the birds so recently that their sharp differences from trees with respect to climatic conditions necessitated a very considerable change of action by the birds in order that security under the new conditions should be as great as under the old conditions. This problem the birds have successfully faced—*somehow*.

The subtle questions of exactly how the various environmental factors, the intense heat and light of summer sun and the storms of rain, snow and wind of winter have operated in the case we leave untouched for the present. Likewise do we leave untouched the still subtler questions of how the sensory, neuromuscular, glandular and other organic systems of the birds have operated. It is quite probable that experimental researches could be devised that would contribute to the answering of these questions. And efforts to this end are highly desirable since knowledge thus gained would tell us much about how the welfare of this species of woodpecker is secured in this particular situation through the working together of the various anatomical, physiological and environic elements involved. But such efforts are for the future and other zoologists than the present writer.

We now take up the single instance to be described of maladaptive action.

Having noticed along the highway power line poles that had been victimized by the woodpeckers to such an ex-

tent that they looked to be considerably damaged, while at Placerville I interviewed on the subject some of the "line men" of the Pacific Gas and Electric Company. One of these, Mr. Lombarde, proved to be genuinely interested in the performance of the birds and well informed on the matters I wanted to learn about.

He furnished ample proof that in some cases the poles are so extensively riddled, especially by the nest holes, that they have to be replaced. Blocks sawed from poles thus treated were shown me which showed that the nest cavity may be so large as to leave hardly more than a shell of wood. When this sort of thing happens to a pole of a high voltage line, there is nothing for it but to take the pole down and put up a new one—which may incur an expenditure of something like $200. However, my informant hastened to assure me that the company does not consider it has any real case against the birds—because the total damage done is so slight as compared with that coming from other sources, particularly from forest fires.

But the special point here concerns acorn-storing more than nest holes. Nearly all the larger poles used by the company are whole tree-trunks of the "Oregon pine" (really the Douglas fir, *Pseudotsuga taxifolia)*, the trees selected being from eight to ten inches or a foot or more in diameter at base. The bark is, of course, all removed. Now what particularly interests us—and the woodpeckers—is the great way such poles have of cracking. The cracks may be many feet long and the largest of them may extend nearly to the center of the pole. Nor is any portion of the pole from bottom to top or any part of the circumference immune from them. These cracks are a great asset to the woodpeckers for their acorn-storing industry.

For several years I had been noticing that the nuts deep down in the cracks may be considerably flattened and in advanced stages of decay. Not until I was shown a pole by Mr. Lombarde that had recently been taken down had I been able to examine the contents of the cracks throughout the entire length of the poles, and to appreciate the full extent of this fate of the acorns. For quite naturally it is exhibited better in the upper part of the poles than near their bases, where alone I had heretofore been able to examine it. And my guide explained to me at once how the flattening and undoubtedly to a considerable extent the rotting of the nuts came to pass. The storing is, of course, done in the fall when the acorn crop is ripening. The acorns are then not only placed in the cracks but are pounded in—as is the birds' typical way of doing the business. Thus are the cracks which are wide open at this, the height of the dry season of the year, filled, often to the very surface of the pole, with the nuts.

Then comes the rainy season. Poles, cracks, acorns and all become thoroughly soaked. As a consequence the swelling wood tends to shut up the cracks—with the inevitable result to the stored acorns. Inevitable too are the consequences exhibited by the nuts when in the middle of the following dry season the cracks are again open, and the nuts are released from the vice-like pressure to which they have been subjected for months while thoroughly waterlogged.

Of the quart, more or less, of acorns extracted from two or three cracks of this pole, which I brought home as a sample, a majority remind one of pieces he might cut, or break, from the sole of an old dry shoe, the last wearing of which had subjected it to black, sticky dirt. I judge, but was not so informed, that this pole stood by the side of a road from which passing traffic raised much dust after the acorns were stored but be-

fore the winter rains came. And surely the acorns described are just about as available for woodpecker food as the comparable scraps of sole leather would be. A great majority of the acorns here stored for food are stored in such fashion as to make them quite useless to that end. The purpose for which the activity is performed is largely defeated by the way it is performed.

Now we might reason that the factors of contingency here involved—the weather and the expansiveness of wetted wood—reach into the future so far relative to the date of storing, and depend so much on physical principles, that even "wiser heads" than any zoologist ever supposed woodpeckers or any other avian species to possess might fail to foresee what would happen. The failure might be supposed due to insufficient experimental knowledge rather than to mere responsive or instinctive action. Possibly there is something in such reasoning. The known facts are not quite conclusive against it. But on the whole the evidence indicates that experience counts for little or nothing toward correcting the great liability of the woodpeckers to store the acorns in such a way as to sacrifice them largely or wholly as food. Much evidence to this effect I have presented in earlier publications. I merely mention—without details—a striking observation to this effect made on this same trip. A long-abandoned miner's house not far from Angels Camp was in full possession of the woodpeckers and was riddled with holes of the acorn-storing kind. The box-like window and door casing were particularly utilized in this way. The nuts put through the holes here drop into the inclosed spaces and are lost to the birds. Removal of the casing boards discovered great quantities—surely thousands—of acorns in these spaces. These nuts are a total loss to the birds. As for the poles, it is almost certain that the birds go right on putting acorns into cracks autumn after autumn only to be wetted, squeezed and rotted to uselessness the following winter.

After due allowance is made for the need of experience here as insurance against wasteful action, failure to profit by the knowledge, once it is had, must be accounted as maladaptive action.

It is quite worth recording, I think, that observations by farmers, line men and others whose residence and vocation bring the woodpecker much to their notice fix upon the birds these contradictory reputations.

Thus a road worker on Mooney Flat mentioned before any reference of mine to the selective placing of the nest holes that birds make their holes on the north sides of the poles as a protection against the winter storms. Without hesitation common knowledge dubs such action as "intelligent," "knowing," "brainy" and so on. Contrariwise, Mr. Lombarde, the line man, narrated to me that when one of his fellow-workmen expressed perplexity as to why the great amount of pecking and pounding done by the birds does not "jar their brains out" the reply of another workman was that they "do not seem to have any brains to jar out."

The only bit of philosophizing I venture at present in connection with such facts as those here recorded is this. The more I study the lives and actions of animals under natural conditions, the less am I inclined to think about and describe what I observe in such terms as instinct, intelligence, reason, thought and so forth, and the more do I think and speak about the phenomena in the terms of what the actions do or do not accomplish relative to the well-being of the creatures as individuals and as species.

It seems to me that much as we zoologists have made and must make of the concept of adaptation we have not made

nearly enough of it in its applicability to the *activities* of animals as contrasted with their *morphology*.

Such facts as that the California woodpecker can use its whole characteristic woodpecker mechanism to such strikingly different ends from what other species use theirs, without any recognizably corresponding morphological difference, seem to me more important for the interpretation of animal life generally, and human life particularly, than either our biology or psychology has recognized. And a fact that makes such studies as these significant far beyond the relatively simple cases themselves is exactly the simplicity of the phenomena. By this I mean that the creature's morphological characters and its activities are so easily observed, and are so close up, as one may say, to the vital needs which are the main goal of the actions, that there is little difficulty in bringing the entire group of phenomena into the picture at one time. For instance, it is almost impossible not to recognize both the purpose (speaking broadly) of acorn-storing by the California woodpecker, and the means by which this is done. Consequently relatively little thoughtful attention is requisite to enable one to see how much of success and how much of failure attend the activities, various of the obstacles they meet, how the birds utilize the stored materials, and so on. Very different as to details is this from the problem of observing the morphological characters of, say, a five-year-old child, correlating its actions with these, and assessing the actions on the basis of their promotion, or otherwise, of the child's well-being. Yet, unless we are all wrong in our modern theory of the nature and origin of man, the two cases can not differ down at the very bottom.

SCIENCE SERVICE RADIO TALKS

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MEASURING THE EARTH'S ATTRACTION

By Dr. PAUL R. HEYL

PHYSICIST, U. S. BUREAU OF STANDARDS

A SAILOR is climbing the rigging of a ship. With one or both of his hands he is always firmly grasping a rope lest his foot should slip. A watcher on shore, with his hands in his pockets, feels a sense of security in that both his feet are firmly planted on solid ground. And yet what is his real situation? He is precariously hanging on by his feet to the outside of a great globe which is whirling rapidly in space.

Few persons ever stop to think of this. Some do not believe it. But one might be pardoned if, when the realization of that fact first dawns on him, he instinctively reaches out for something to catch hold of, and feels that after all the sailor may have been in rather the safer position.

The attraction of gravity is such a commonplace that we are for a large part of the time unconscious of it. Only when it becomes necessary to climb stairs or to lift trunks does it force itself upon our notice. It is, however, a matter for study and careful measurement on the part of scientific men, and measurements of the earth's gravitative pull are among those in which a high degree of precision is reached, something like one part in a million.

But why should any one go to the trouble of obtaining so precise a result? What is it good for?

It is one of the duties of the U. S. Coast and Geodetic Survey to map this great country of ours as accurately as possible. Now the surveying of large areas differs from small-scale work in that the curvature of the earth must be taken into account. It is not sufficient to assume that the surface is spherically curved, even on the Great Plains. One of the best ways of determining the change of curvature of the earth's surface is by the variation in the pull of gravity at different places. Where we are farther from the earth's center, the pull of gravity is less. But since such departures from spherical form are always very small compared to the size of the earth, we must be able to measure gravity very accurately indeed if the results are to be useful.

There is now in progress at the Bureau of Standards a measurement of the earth's gravitational attraction in connection with the map work of the Coast Survey. Determinations of gravity are made throughout the United States on a comparative or relative basis, with reference to a base station, where the value of gravity should be known to as high an accuracy as possible. While it is a comparatively simple matter to compare different values of gravity with one another it is quite another thing to determine the absolute value of gravity at the base station.

Now it happens that our Coast Survey has never had a real base station for gravity in this country. The measurements throughout the land have been compared, it is true, with the value of gravity at Washington, but the value at Washington traces its pedigree from the absolute gravity station at Potsdam in Germany. It is by no means as simple

a matter as it appears to extend comparisons of gravity across the ocean, and without a base station of our own we are not quite sure of our ground. The experiments now in progress at the Bureau of Standards are for the purpose of establishing such a base station in our own country.

Another use for gravity determinations is in prospecting for oil. The old method of drilling holes more or less at random (called "wild-catting") has become much too expensive. Wells are sometimes drilled very deep nowadays before striking oil, and the cost of a failure, or "dry well," may run into five figures. For this reason much attention is given at present to the use of physical methods of detecting underground deposits as a guide to favorable locations for drilling wells.

One of these methods depends upon the measurement of the force of gravity. The pull of gravity may vary because of the nature of the material beneath the surface at different places. Perhaps there may be underground a large body of rather heavy rock, or again there may be a deposit of oil, very much lighter than the average crust of the earth, and consequently less attractive (from a gravitational point of view). Many an oil well has been discovered in this way; but it will be obvious that if the deposit is very deep it will require great precision in our gravity measurements to detect its presence.

How is the pull of the earth measured? There are several ways in which it can be done more or less roughly, such as by the use of a spring scale, or by measuring the speed attained by a falling body, but the most precise way is by means of a pendulum.

A pendulum swings because of the earth's attraction. Draw its bob to one side and release it; the earth tries to draw it vertically downward, but being rigidly connected to its point of support the only thing the bob can do is to move downward along a circular path. At the bottom of its swing, having acquired considerable momentum, it rises along another arc of a circle, gravity acting against it all the while, and eventually bringing it to rest. The cycle of motion is then repeated.

The time of swing of a pendulum is determined by two things: the force of gravity and the length of the pendulum. Consequently, if we measure the length of the pendulum and determine its time of swing we can calculate the value of gravity.

Both these measurements of length and time are capable of being carried out with a high degree of precision, and in consequence no other method of determining gravity can approach the accuracy of the pendulum. But to insure precision many precautions must be taken.

A pendulum suitable for gravity determinations is not at all like such pendulums as you may see in clocks, with a heavy bob and a rather light suspending rod. Such pendulums are far too flexible for purposes of accuracy. Gravity pendulums for absolute determinations are constructed so as to be as rigid as possible, usually of hollow tubing.

Much attention must be given to the mode of supporting the pendulum. In ordinary clocks and even in those used for astronomical purposes the suspension is usually a piece of flexible watch spring. But for gravity pendulums it is important to know the exact point of support, which is difficult to locate in a flexible strip. For this reason the pendulum used in precision measurements is usually supported by a smooth plane resting on a knife edge of agate or fused silica.

The expansion of the pendulum by rise of temperature may introduce error. To avoid this the experiments at

the Bureau of Standards are carried out in a room 35 feet below the ground, where the temperature changes very slightly from winter to summer. In addition, the material of the pendulum must be one which expands but little with rise of temperature. The best substance for this purpose is fused quartz. This, of course, makes a very brittle pendulum, but the greater accuracy attainable is worth the trouble and time involved in working with such fragile material.

In addition, the pendulum is swung inside a metal case from which the air has been exhausted. This permits the pendulum to swing for a long time, and also eliminates certain disturbing effects that would otherwise be caused by air currents or frictional resistance.

The length of the pendulum is measured by comparison with a standard bar (also of fused quartz) which has been compared with the standard meter bar which is by law the basis of our measuremental system. The time of swing is determined by means of an astronomical clock whose rate is checked daily by the Naval Observatory time signals.

A rather curious feature of this experiment is yet to be mentioned. After the pendulum has been swung and measured with all the precautions that have been spoken of, it is turned upside down and swung again from another point of support. Were the pendulum perfectly uniform all along its length, this would not be necessary; but as such symmetry is never attainable, the pendulum must be swung in the reverse position also to eliminate these irregularities.

It may be readily understood that such a program of experiments may be expected to require considerable time. It is likely that the work will not be completed for several years, but when it is finished, the United States will be independent of any other nation in the matter of a base station for its survey work, and (we hope) the scientific world will be the richer because of a new determination of gravity of higher precision than has ever before been executed.

THE ANCESTRY OF OUR TREES

By EDWARD W. BERRY

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BERNARD—the finest flower of medieval monasticism (1090–1153) — said: "Trees and rocks will teach what thou canst not hear from a master," and it is of trees in rocks that I would tell you.

Some of us take great pride in our ancestry, and every one in these days when evolution is so much discussed has heard at least something of the ancestry of man and of the lower animals. Few, however, even among lovers of flowers and trees, have given much thought to the possibility of our favorite trees having had ancestors, or that the evolution of plants is quite as fascinating a field of study as is the field of animal evolution.

The stage setting is the same for plants as for animals only the time involved is somewhat longer. Plants are essentially the gatherers and storers of energy, while animals are essentially expenders of energy. Consequently animals must have plants for food. Hence plants were the first organisms.

The latest fraction of earth history, which we call the Tertiary period, comprises—according to recent studies of the atomic disintegration of uranium

and thorium minerals—something like 60,000,000 years. This period is commonly called the Age of Mammals, since it is during this time that the mammals or warm-blooded animals underwent their main evolution which culminated in the anthropoid apes and in man.

This same period may also properly be called the Age of Flowering Plants, since it also witnessed the main evolution of plants with flowers which produced seeds in closed seed vessels or fruits. The only difference in this respect between flowering plants and mammals is that the flowering plants started on their careers of world dominance some millions of years earlier than did the mammals, and there is a clear dependence of warm bloodedness on concentrated food which in the whole plant kingdom is produced almost wholly by the flowering plants.

Not only so but civilization itself was not possible until the invention of agriculture made possible the fixed abode and larger population denied to hunters and pastoral peoples. All our food plants are flowering plants, and this was not an accident but the inevitable result of their storage of concentrated foodstuffs in seeds or roots.

Toward the close of the Age of Reptiles, which preceded the Age of Mammals, we encounter the fossil remains of flowering plants in the rocks—petrified stems, casts of seeds, but chiefly the impressions of foliage, although in very fine-grained muds or fossil gums we may find preserved actual flowers. These early traces of the flowering plants are mostly of trees since trees stand a much better chance of being preserved in the sediments which formed the rocks before dissolution could overtake them. Among these early relics of long extinct forms we can recognize the ancestors of most of our familiar forest trees of the present.

Whether it be oak or chestnut, walnut or hickory, maple or ash, willow or poplar, sycamore or magnolia—all represent noble traces of an ancient lineage beside which the Cretan labyrinth, Ur and Nineveh are as but yesterday. Still living sequoias were young trees when Christ was born at Bethlehem in Judea; still living cypress sheltered Cortez on that night when the Aztecs almost succeeded in exterminating their conquerors. Still living sycamores were witnesses of De Soto's wandering in our Southern states.

Should we not then consider our trees as a part of our spiritual resources instead of purely an economic resource, and strive to get back a bit of that reverence of classic times when the forests were the abode of the gods?

The story of our tree ancestors is not only of their past distribution in time but also their distribution in space. Time and place then are the main themes, for we find that in the past they have been found in many countries where they no longer exist. For example, before the modern mountains were elevated in our West we find the remains of forests with magnolias and tulip trees, sassafras, gums, hickories and many others, which have since become extinct in that region and which survive in only eastern America and eastern Asia. Or in Europe before the glacial period wrought such havoc with its floras and faunas, we find many Asiatic and American trees—walnuts, hickories, magnolias, gums, sassafras, tulip trees, cypress and sequoia, and a host of others, since destroyed by the severe conditions of the ice ages, because their avenues of retreat were cut off by the Mediterranean and the transverse mountain chains of the Pyrenees, Alps, Carpathians and Caucasus.

We may trace briefly the history of a few familiar types.

The hickory, long considered to be a typical American tree, may well be taken to typify the spirit of the American pioneer, for its wood combines strength

and toughness to a degree unequaled among other trees. All the living species, except one recently discovered in China, are confined to southeastern North America. In those distant days when the primitive mammals had vanquished the last of the dinosaurs we find the fossil leaves of the hickory for the first time, and these oldest known records come from the western interior of North America. Somewhat later we find their remains in Europe and gradually their range was extended over the greater part of the Northern Hemisphere. The Ice Age exterminated them in Europe, and the elevation of mountain ranges which intercepted the moisture-bearing winds drove them out of western North America and most of Asia.

Our present trees are fine, slow-growing and long-lived trees—as many as 400 annual rings have been recorded; and undoubtedly if they had not become extinct in Europe before the advent of man they would have quite as many legendary qualities and poetic allusions as their relatives, the walnuts, or as the oaks.

The next tree that we will consider is the oak. The oak family, which includes the equally interesting chestnuts and beeches, took its origin from an extinct type which was abundant in the late Cretaceous and early Tertiary at a good many localities in the Northern Hemisphere.

The oak was Jove's own tree, according to Vergil, and it has always been an object of veneration and sentimental tradition. The Greeks supposed it to have been the first tree, and it was sacred to Zeus since it had sheltered his cradle on Mount Lycaeus. We read in the Old Testament that Jehovah appeared to Abraham beneath the oak tree at Mamre in Hebron, and in later times altars were built to the supposed Abraham's oak. Tree worship is hinted at in the story of Gideon, to whom the Lord appeared under an oak in Orphrah and told him he was to save Israel from the Midianites.

A great oak tree in Hesse dedicated to Jupiter was felled by order of Bonifacius and a chapel to St. Peter was built of its timber. The oak and mistletoe were part of the druidical cult in early Britain, and in more modern days it was believed that the spirit of the oak took refuge in the mistletoe during winter, when the trees were leafless. The old custom of bringing mistletoe into the house, so that the tree spirit might bring good luck to the household, is the origin of the modern use of mistletoe at Christmas time.

There are historic oaks in every region where large old trees are found—Charlemagne's oak near Paris; the Abbot's oak at Woburn, where Henry VIII hung the Abbot in 1537; the oak in the New Forest against which the arrow that killed William Rufus is said to have glanced; the Royal Oak at Boscobel in which Charles II hid after the battle of Worcester; the William Wallace Oak at Torwood; Alfred's Oak at Oxford; the Charter Oak at Hartford; the Wye Oak in Maryland, and many others.

The oak is especially esteemed by the Anglo-Saxon race not only as the monarch of the forest, which, turned into ships, would forever preserve English liberty—but more as a fit symbol of their character that might yield to adversity but which was not to be uprooted or changed by passing storms.

Not only did maritime folks appreciate oak planking, but the lowly keepers of the swine appreciated the bounty of the oak, in fact the Greek *choiros*—a pig, is in allusion to acorns; and tradition has it that acorns were the staple food of humanity before Demeter introduced grain on the earth.

In the Doomsday Book the forests are enumerated for taxation by the number of hogs they could fatten.

Although the oak may be the monarch of the forest in the temperate zone it is by no means confined to that region, but is well represented in most equatorial regions except Africa and South America. The West Indies have a number and there are over 300 varieties in Central America.

Although so abundant at present the oak line is ancient, and doubtless their leaves were eaten by herbivorous dinosaurs. The leaves of the more ancient species are with difficulty distinguished from those of the chestnut and the beech, and hundreds of fossil kinds have been described. They seem to have had a northern origin and are found in Greenland, Alaska, Iceland and Spitzbergen in Upper Cretaceous and early Tertiary times. In glacial times oaks have been found in cave deposits and river terraces, and there is a species associated with the bones of the ape-man in Java.

The sweet gum belongs to the same family as the witch-hazel, a family all the members of which have a curious disconnected present distribution indicative of an ancient lineage.

No part of the temperate zone can compare with southeastern North America in the brilliancy of autumnal colors. And a considerable part of this is due to the golden yellow to carmine and wine-red of the star-shaped leaves of the sweet gum. It is only in recent years that we have discovered the beauty of gum wood for interior use; it is now often called satin walnut.

The modern range is from southwestern New England to Florida and east Texas. It reappears in the uplands of Central America, and other varieties are found in Formosa, Japan and southern China and Asia Minor. Formerly the ancestors of the present trees had a continuous range, and the score of extinct species that have been found in the rocks largely bridge the present-day gaps in distribution and carry the ancestry back to the early Tertiary. The oldest of these gums come from Alaska, Greenland and Oregon. Somewhat later they appear in southern Europe and toward the close of the Tertiary at many localities in central and southern Europe, Asia and western North America.

Their characteristic fruits, often called gum balls, have been found fossil at a great many localities. The gum seems to have flourished in Europe right up to glacial times, when like the walnut and so many other tree species it was exterminated by the harsh climate.

What has been so briefly sketched for the hickory, gum and oak is true of most of our forest trees. We need not grow sentimental about "Woodman, spare that tree," but nevertheless fire and the lumberman have worked more havoc with the forests in a few hundred years than all the natural vicissitudes of time, and surely a more general appreciation of the wonders of the past history and present beauty of trees might well replace that attitude that regards our forests as so many potential board feet and we might remember that a tree is no longer a tree when it is lumber.

THE SUN

By Dr. C. G. ABBOT

SECRETARY, SMITHSONIAN INSTITUTION

In the first chapter of Genesis we read: "And God made two great lights; the greater light to rule the day, and the lesser light to rule the night." The lesser moon inspires the poets; but the greater sun inspires all life.

Our earth circles about the sun once each year, at the immense distance of 93,000,000 miles. Sometimes we are asked: What set the earth going, and why doesn't it run down and stop like a boy's top? Well, I can't tell you what set the earth going, or how many thousand million years ago it was. But the reason it keeps going is just that there is nothing to stop it. A boy's top slows up and stops because of the friction of its pivot and the friction of the air. The earth rests on nothing, and goes through empty space; so there is no friction or resistance of any kind to slow it up. Yet it can not escape from its liege lord, the sun, because the attraction of gravitation acts like a slightly flexible bar of enormous strength to hold it to the sun like the spoke of a wheel. The spoke, to be sure, expands and contracts a little each year, for the earth is about 3,000,000 miles further from the sun in July than in January.

Immediately you begin, perhaps, to think I've made a slip of the tongue, and meant to say that the earth was further from its source of heat in January than in July. But no. For quite another reason we find it cold in winter. It is because the sun is not then overhead, but is far to the south. So its rays are spread much more feebly over the surface of the earth in winter, and can not warm us so much as when shining more directly down in summer.

While we talk of the sun's heat, let us take up another question sometimes asked. Why is it, says some one, that if the sun's rays keep the earth warm it grows colder and colder the higher we go in the air, though we are approaching the sun all the time? It is because the air is so transparent. It's like the window-pane that always stays cold because it absorbs so little heat from the sunbeam that passes through it. When one ascends a high mountain, or in an airplane, the cold air rushes about and chills him just as it does the radiator of his car. The upper air is cold because it is transparent and it cools whatever it blows upon. As for going nearer the sun when one ascends, what is a mile, or even five miles, compared to the 93,000,000 miles to go to reach the sun?

Perfectly tremendous quantities of energy are contained in sun rays. If we could use them completely to do mechanical work, every square yard shone on directly by sun rays would furnish over one horse-power. The state of Arizona might furnish sun-power equal to about twice as much as all the power of coal, oil and water now used in the United States if there were solar engines of only 10 per cent. efficiency all over Arizona to convert solar energy into work. Hitherto such solar engines have all been too costly to make and run, since other power is made so cheaply. Perhaps it will be otherwise a century hence, and then we may find the great manufactories in desert lands where there are fewest clouds.

What supplies the sun itself with such an enormous output of energy? Astronomers and physicists now think that the sun and all the stars are gradually consuming. I do not mean that they are burning up as coal is burned. When coal is burned it takes on oxygen, and the product in carbonic acid gas is nearly four times as heavy as the coal that is burned. Strange, isn't it, to think that what goes up the chimney weighs nearly four times as much as what is shoveled into the furnace? Nothing like this takes place in the sun. The temperature there is so tremendous that water would turn to steam, the steam into oxygen and hydrogen, and the atoms of oxygen and hydrogen largely into electrons and protons, and all this with explosive violence if any water at all could reach the sun.

All chemical compounds are thus

broken up in that fierce heat. We have nothing on earth so hot. Iron melted in a blast furnace would look like a black spot against the sun, and even the arc light would seem a dull red glow against such transcendent brilliance as the sun's surface. If, then, the sun is much too hot to burn, even on its surface, and perhaps ten thousand times hotter still at its center, what do we mean by that consuming that gives out its tremendous radiant energy? We mean nothing less than the annihilation of the solar substance. Take hydrogen for example. Its atom, so far as we know, consists of nothing but a separation of two units of electricity, one positive, one negative, kept apart by some tremendous energy of motion. We suppose that in the center of the sun, under prodigious pressure and exalted temperature, the two electricities may sometimes be forced together. When thus the atom ceases to exist, the energy that formerly forced its two units of electricity apart appears as radiation, and journeys outwards into space.

Things are built on a tremendous scale in the sun. It is 860,000 miles in diameter. This is about 100 times the diameter of the earth, and the sun weighs over 300,000 times as much. It is not solid like the earth, but gaseous altogether. Still the gases are so tremendously compressed that if we examined them we should be apt to call them liquids. The sun, indeed, averages 1.4 times as dense as water, whereas the air we breathe is only about 1/1000 as dense as water. But gases get denser the more they are compressed, and with solar gravitation, even at the sun's surface, of nearly 30 times its force on earth, the compression of the gases in the deeper solar layers is tremendous.

The telescope seems to show little on the sun as interesting as the mountains, craters and smooth plains that fill the landscape of the moon. But we have to remember the scale of things. A sunspot that occupies only a fiftieth of the diameter of the sun's face is yet big enough to enclose at the same time two whole earths and two whole moons without touching the sun-spot's edges. A little bright dot called a faculus, that seems inconspicuous on the sun, may be big enough to match the whole land surface of our globe. Thus, viewed in the light of our knowledge, the solar features take on their true proportions.

Not only does the sun keep the earth warm enough to live upon, but it is the original source of practically all our power. By the preservation of coal and oil the sun's share in the growth of the vegetation of ancient times is preserved to us. By the flow of streams his present activity in evaporating the water of the oceans is conserved for hydroelectric power.

The most fundamental chemical reaction in the world depends on the sun rays which promote the growth of plants. Within their leaf cells the carbonic acid of the air is combined with the water drawn in through the roots. The product is grape sugar. From this as the raw material the complex substances of plant life, the delicious juices of the fruits, the oils of the nuts and the cellulose of the woody fiber and the leaves of plants are all built up. Only in the rays of light does this wonderful first step in plant chemistry take place. No plant may grow without light. Without plants there would be no animals or human beings, since plants are the primary sources of their food. Thus the chemical reaction whereby light makes plant sugar is the most fundamentally essential one to all life upon the earth.

At the Smithsonian Institution we are making studies about this fascinating subject. We are growing plants out of jars of water containing suitable chemical plant foods. They stand in closed

chambers where sunlight can be imitated by electric lights. We control the color of the light and seek to know just how efficient the different colored rays are to produce plant growth. Thus, without sight of sun or feel of earth, our plants are grown under closely measured conditions. This will bring new knowledge of exactly what is necessary to make plants grow in natural surroundings. Perhaps improved varieties of useful plants may result from such studies.

Another very interesting experiment we are making relates to the bending of plant stems towards the light. A long dark box has within it a light at each end whose colors and brightness may be exactly controlled. A little oat seedling grows up out of a flask of watery nutrient in the middle of the box. If it bends towards either light, the brightness of that one is reduced by the observer until the plant grows straight up. Thereby we measure the relative efficiency of different colors to promote this plant bending called phototropism.

In other experiments we are trying to learn more about the secrets of solar plant-chemistry. Ordinary analysis of complex organic chemicals does not easily reach to make known the structure of their molecules. We are endeavoring to build up a spectroscopic method which will give a deeper insight into these complex structures, such as the green chlorophyl of the leaves, and the far more ponderous molecules associated with plant life. How complex they are may be partly appreciated when one notes that molecules of certain types of individual plant substances contain as many as 30,000 atoms. Compare that with hydrogen or with oxygen whose molecules each contain but two atoms.

The final thing I have time to mention to-day about the sun is that it controls our weather. Summer and winter, day and night succeed each other as the sun appears higher or lower above the horizon. The atmosphere circulates in immense whirls and spirals according to the warming and cooling which attend the march of the sun in the heavens. The winds blow and the rain falls entirely because the sun supplies the energy involved.

Within recent years the Smithsonian Institution has established several solar observatories on high mountains in distant desert lands. Here our observers measure patiently, day after day, the exact strength of the solar rays on which the world's weather depends. Changes are found, some regularly periodic, others apparently haphazard. We hope that when a longer series of these values has been accumulated, weather men will be able to puzzle out the intricate effects which the solar variation leads to. Then it may be that seasonal forecasts of reasonable accuracy will result, to the great advantage of industry.

WHAT THE NATIONAL PARKS MEAN TO THE AMERICAN PEOPLE

By Dr. RAY LYMAN WILBUR
SECRETARY OF THE INTERIOR

THE United States is fortunate in possessing, in its matchless national parks and monuments, a system of outdoor museums which offer almost unlimited opportunities for enjoyment. I have been asked to talk especially about education in the national parks. The term sounds formidable, but as applied

to the national parks education is but one form of the enjoyment to be derived from a park visit. Our nation is still a young one, and like all young things is consumed with a curiosity as to the "why" of things. It is that spirit which has made us successful in the development of the resources of our country and in science and invention. So it is but natural that it must be carried into our recreation.

It is not enough for most of us to go to a national park, hurriedly view its highest mountain, greatest waterfall or immense canyon, and then go on to something else. Except for the almost professional "tripper," most of us want to know something about the mountain, whether it was once a volcano and if not what caused it. We want to know how the canyon came to be, and the cliff over which the falls tumble. So, for lack of a better word, we call the service which meets this demand for information educational.

Perhaps a few words about the principal characteristics of the major national parks would not be amiss here. Several of them are of volcanic origin. Best known of this class is the Yellowstone. This, the first national park to be created in this or any other country, has six great geyser fields, with thermal activity that can not be matched anywhere. It also has a canyon of unusual beauty, a great lake and interesting mountain scenery. It is said to be a dying volcanic region; that the geysers are the last gasps of the old volcanic forces. This may be so, but after viewing one spot in the park known as specimen ridge, one wonders if the age in which we live is not merely an interlude between two great volcanic periods. Specimen ridge is a 2,000-foot cliff where nature in some way cut through a great plateau. Imbedded in this cliff may be seen the remains of twelve fossil forests, one above the other. The scientific explanation is that the first forest was engulfed and buried under an irresistible flow of volcanic mud and ash. Then volcanism ceased and sufficient earth accumulated on top of the ash to support another forest. This later suffered the fate of the first forest. So for countless ages volcanic activity followed periods of quiescence during which forests thrived. Who knows but what Yellowstone's forests of to-day may be the thirteenth fossil forest of geology's to-morrow? Visitors to the region are particularly interested in the hot springs, and one of their frequent questions is, "What happens to the hot springs in winter; do they freeze up?" Others, when told of the plants of the Arctic zone to be found in the park, ask, "How did Arctic plants get to Yellowstone from the Arctic Circle?" Since asking such questions is one of the amusements of park visitors, answering them has become one of the important duties of the park forces.

Mount Rainier Park, in the State of Washington, is the result of two forces of nature, volcanism and glaciation. As we know it, the huge mountain is sheathed in ice, containing our largest single-peak glacier system. Seen from an airplane, the glacier looks like a giant white octopus, for from its summit twenty-eight named rivers of ice, and many smaller ones, pour slowly down its sides, reaching out into the great forests and delicate flower-fields below. Yet Rainier also was once a volcano, and even to-day sufficient steam comes from inside the earth to melt holes in the snow near the summit. The bed of beautiful blue Crater Lake in the park of that name is the crater of an ancient volcano.

Glacier National Park, adjoining Canada's Waterton Lakes Park at the international boundary, is, as its name signifies, partly the result of glaciation. Before glaciation, however, a great cataclysm occurred in the interior of the

earth, and the pressure under what is now Glacier Park became unbearable, so that the surface of the earth cracked and one side was thrust up and over on the earth.

Our newest national park is the Grand Teton, containing the lofty Grand Teton Mountain group. Unlike the volcanic mountains of nearby Yellowstone, this range is composed primarily of gneiss.

Rocky Mountain National Park contains a typical section of the Rockies. The Front Range, which carries the Continental Divide, is a gnarled and jagged rampart of snow-splashed granite which, although not the highest or most massive part of the Rockies, is for many reasons representative of the noblest part of these mountains.

Yosemite Park, in California, is a wonderful mountain area, containing part of the Sierra Nevada Range. Among its most striking features are its beautiful valleys, part the work of erosion and part of glaciation. Spectacular waterfalls dash over the great gray cliffs. The valleys here were first dug out by streams cutting their way through the solid granite. Then came the glaciers, digging deeper, scooping out and polishing. In this part also the educational force has many questions to answer. One most often asked in Yosemite Valley, when massive Half Dome, high on the rim, is first seen, is "What happened to the other half?" The searcher after information is told that it was split in two by the forces of glaciation and that the missing half is now among the boulders that are scattered down the Mercer River Canyon at its base.

Sequoia National Park, also in California, contains another outstanding portion of the High Sierra, including Mount Whitney, our highest mountain outside of Alaska. This park and its little neighbor, General Grant, were originally reserved because of their giant sequoia trees, thousands of years old and some approaching forty feet in diameter, which now grow only upon the western slope of the Sierra Nevada. The ranger or naturalist who tells the great age of these trees must be prepared to substantiate his statement. It is easy to do so where the sequoias are concerned. While the exact age of the living trees can not be given, it can be estimated by comparison with other trees which for some reason died, fell or were cut across. For every year the tree has lived there is an age ring, and many trees have been counted that bear over two thousand age rings, and some over three thousand. John Muir, our famous California naturalist, told of having counted four thousand rings on one.

That portion of our Southwest included in southern Utah and northern Arizona is a region of colorful canyons. Three of the most distinctive of these gorges have been set apart as national parks. The fame of the Grand Canyon is world-wide. Here the Colorado River, working hard through the ages, has cut a great gorge nearly a mile deep and varying in width, inside the park, from four to eighteen miles. Seen from the rims, the river looks like a tiny ribbon winding its way through the maze of towering cliffs, but on approach it is seen to be a mighty, turbulent river, still, as may be seen from the load of brown sediment it carries, cutting away the earth as it rages toward the sea.

Zion and Bryce Canyon National Parks, to the north of the Grand Canyon, are entirely different. Zion Canyon is about the size of Yosemite Valley and is said to resemble it in general conformation, but its great domes and spires are distinctive in their carving and glow with a richness of color that is unsurpassed. The gorgeous red of Utah's Vermilion Cliff is the prevailing

tint for two thirds the way up the canyon walls, with startling white above.

Bryce is really not a canyon, but a great horseshoe-shaped bowl extending down a thousand feet through pink and white sandstones. This great bowl or amphitheater is filled to the brim with myriads of fantastically carved figures.

One of our parks, the Mesa Verde in southwestern Colorado, contains a marvelous collection of prehistoric Indian cliff dwellings and pueblos, the ancestors of our modern apartment houses. The most picturesque of the great communal dwellings were built in huge caves, where they were protected to a great degree from the elements and where they were difficult of access by hostile tribes. Others appeared simply as great mounds of earth when first seen by white men, but when carefully excavated revealed ancient dwellings.

The only national park in the East so far is the Acadia, on Mount Desert Island, Maine. This is also unique in being the only one where the sea and mountains meet.

Three other national parks are in process of establishment in the East. One is the Great Smokies area, taking in the most distinctive portion of the southern Appalachians. Another is the Shenandoah, in the Blue Ridge Mountains of Virginia. This area is also replete with historical associations dating back to early colonial days. Mammoth Cave is the third of these park projects. Under authority of Congress all these parks will be established when certain designated areas have been donated to the United States for park purposes. Under congressional direction the Florida Everglades in the Cape Sable region have also been studied recently, to determine the suitability of the area for park purposes.

In addition to the main, distinguishing features of the parks already referred to, most of them have a very interesting plant and animal life. We are endeavoring to preserve these areas as nearly as possible in their natural condition, compatible with increasing human use.

The so-called educational work in the national parks consists in explaining to those interested, in popular form, the peculiar formations which are the distinctive features of the park, and telling which of her powerful tools nature used in forming them; and in giving information about other natural-history phases of the areas. This information is conveyed in three principal ways—through trips of varying duration conducted by ranger-naturalists; through lectures given by naturalists and visiting scientists at the hotels, lodges and camp-fires in the public camps, and through the museums, which are fast becoming important tourist centers.

The growth of this educational work during the decade since its experimental beginning in 1920 has been phenomenal, and is entirely due to the popular demand for the increased service of this kind. More and more the public is realizing that the parks are more valuable from an inspirational and esthetic standpoint than from that of material recreation. Both uses are desirable and necessary if the parks are to serve their owners, the American people, in the fullest degree.

COMMUNICATION AS A FACTOR IN HUMAN PROGRESS

By RALPH E. DANFORTH

HUMAN progress comprises both constant improvement in living conditions and steady improvement in man. Rapid increase in communication is speeding up both these processes. Communication is like a net thrown around the world drawing mankind together, thereby multiplying his power, for in union there is strength.

The solidarity of the *United* States is the secret of our present prosperity quite as much as our natural resources. The strength of this union over so vast a territory and operating through such lively channels of communication is increasing our power at an almost incredible rate. Another motto, "Knowledge is power," also proves its eternal truth now that knowledge is being communicated as never before to the people of the world.

Communication aids in the discovery of knowledge, speeds up its proper sifting and evaluation and then disseminates it throughout the land. People come to know the truth and the truth comes to make them free. Liberty which does not enlighten is no true liberty.

Communication greatly helps the process of enlightening man and hastens the dawn of genuine liberty both personal and universal. Communication by the many lightning-quick methods now in use speeds the circulation of money in ways which would be absolutely impossible under older modes of communication, and this increased circulation of money increases wealth and prosperity of the people.

With more wealth and happiness the wise can be wiser and fools be more foolish till their folly chokes them and the wise survive. Disseminating knowledge, wealth and power is a more humane way than warfare to kill off the unfit and fortify the intrinsically worth-while folk. Give a man money and power, in short, real success, and he will quickly show what mettle he is made of. Mr. Firestone has said that only a small proportion of men can stand prosperity,

If success goes to his head, by which we mean makes him conceited, he is too small a man; if it goes largely to his belly he is no true man. If prosperity elevates and refines him, increasing his efficiency, adding to his knowledge and making him more useful and more generous, he is then the typical American of whom his country is proud. This type of man, found in abundance in the United States, is making the world take notice and send commissions over to us to see how we got that way. We are communicating to the world, and the world communicates with us. Without efficient and lively communication among ourselves this would not be.

As communication increases in the future results will be commensurate. But communication does not do it all, for unless our race produced a lot of big men no amount of communication would make great statesmen and great business men out of them. For this reason some visiting commissions may find difficulty in reproducing our prosperity in their home lands. Their studies should help considerably in developing whatever capacity for prosperity they possess.

The thrilling thing about world-wide communication is the new form of competition it will introduce between man and man the whole world over—person-

ality pitted against personality throughout the circuit of this earth, compared, contrasted, tested in all ways as to intrinsic values of all parts of the man and all qualities. The physical, mental and moral values of all people will be tried out more searchingly than ever before. People in general will come to see clearly the real value, or lack of value, in certain characteristics which they never thought much about before. They will think seriously and often about many traits and characteristics, whereas before they had paid scant attention to even a few.

A bloodless warfare, though a serious one, will arise between individuals of both sexes and all ages the world over. It will be a friendly warfare, if you can conceive of such a thing, yet inexorable, and before it much that is trash in the human make-up will go down, while lasting worth will stand out in stronger light and beauty. Those who have it in them to develop many of the latter qualities will have cause to congratulate themselves, while those who possess them not will hardly know why they and theirs are disintegrating. Already the forces are at work; they always have been in communities of any size, but the advancement of communication and the increase of knowledge through the inventions, discoveries and diffusion of the results and benefits thereof have greatly increased the competition in human values. The next few years will increase it much more. Old-time warfares are bound to go down before it, but new warfares, less deadly to the worthy, more deadly to the worthless, will take their place.

Not only will individuals be contrasted with individuals but governments with governments, educational methods with other educational methods, social systems with social systems, laws, policies, religions, scientific achievements, hospitals and all other institutions with their kind in all parts of the world will be subjected to the closest scrutiny, compared and analyzed, weighed and evaluated. A flood of light will reach to the remotest abiding places of mankind, and this light of knowledge will be most healthful in its effects. Whether they will or no, nations will be drawn into a federation of universal communication, a united states of knowledge.

The thought of the common welfare will be thrust upon the most selfish peoples; the most benighted will be flooded with enlightenment, and those individuals or groups that find no responsive chords within their being can but shrivel or wilt in the sunlight of knowledge and human progress like plants that have no roots. Like violins without strings they can take no part in the symphony of man, the triumphal march of man's soul.

Rapid changes are going on all around us in response to the diffusion of new knowledge, new machines, new chemicals, new fruits and other foods, new flowers, new sources and more sources of power, new means of travel, transportation and conversation. All this we may include in the scope of communication. One might naturally think that all of us in the more progressive countries would respond more readily and quickly to the further advance of communication in the immediate future than the peoples in the out-of-the-way lands could possibly do. I fear we have in the most advanced lands many individuals who are excessively dull, criminal or obstinate who will not advance as rapidly as the more responsive savages in the now unenlightened corners and jungles. Many individual savages will fail to comprehend or receive the new light of progress, it is true, but we have such savages in fair abundance in our home lands and in our

greatest cities, and also scattered throughout our farming districts. Everywhere they are to be found as well as in the unexplored regions. Everywhere there will be many who will spring with alacrity to the call of real progress, real truth and well-being, with the larger happiness it entails.

All around the world we will read one another's writings. Better than that, we will talk freely and inexpensively with one another around the world. Better still, we will see one another as we converse. Best of all, we will travel universally and cheaply and meet and know one another thoroughly all around the world. No one doubts the rapid improvements in all these lines of communication now before us. Yet it is hard even for the most imaginative to realize all that it will mean to us or to others.

As I write these lines I am enjoying the sunshine and pure air on a high hilltop in Massachusetts. Other articles I have published in this same journal have been reviewed, at times, in publications from India, California and Siam to the islands of the Pacific. Will any who may read this article be led to think more in terms of human progress, and so help speed the progress of man?

In the struggles of culture with culture, science with science, religion with religion, mode of life with mode of life, region with region as a place for human habitation, those cultures, sciences, religions, modes of life or regions contributing most to real progress and improvement of man will be favored, the others will be neglected. Some hangers-on may linger in each neglected field awhile, but like hair on the face of a man who shaves they are doomed. Seek the culture, the religion, the mode of living which holds the strongest stimulus to improvement even toward the point of ultimate perfection and you will find that culture, religion or mode of living which will persist through the ages. The sequence "Learn to do well," "Seek that ye may excel," "Be ye therefore perfect" is the imperishable secret of human progress.

Some regions of this earth now considered unsafe to live in may become favored spots of abode. Victories over tropical diseases are leading to colonization in lands where abundant sunshine favors more rapid growth of timber and fruit and vegetation in general. Many tropical regions are so high in altitude that they are never too hot for health. Regions too hot and regions too cold and regions too changeable can not be held in high esteem in the future.

The advance in communication will favor the mating of the best with the best the world over. A world aristocracy of those who combine healthiest bodies with soundest judgment and clearest vision will increase, improve and refine itself, no longer permitting periodic dilutions with blood of mediocrity. With the help of communication and other factors the excellent of the earth will approximate perfection, the meanest and vilest will approach destruction.

Communication will aid greatly the increase of joy in the world. Beauty will be cultivated and abound. Fragrance and sweetness will fill the earth. Man himself will become healthier and wiser. He will think ever in terms of human progress.

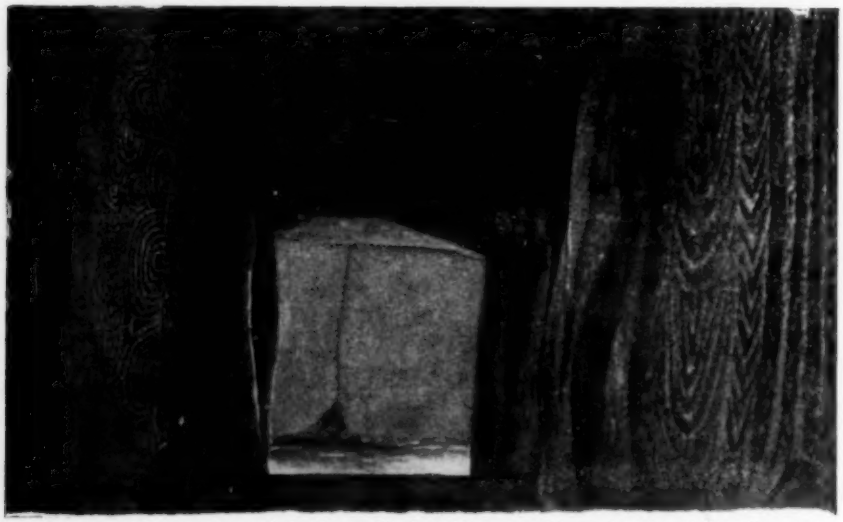
THE "FINGER-PRINT" CARVINGS OF STONE-AGE MEN IN BRITTANY

By Professor HAROLD CUMMINS

TULANE UNIVERSITY

A STORY partly told suggests diverse settings, and except to him who relates it all may seem equally fitting. Attempts to reconstruct the life and thought of prehistoric man are based necessarily upon uncompleted stories, which are revealed in remains of handiwork, sometimes so piecing together as to give consistence to the whole, yet often being quite fragmentary and tantalizing to the restorer. Occasional fantastic reconstructions of episodes in prehistory are inevitable. Carved on the stones of a Neolithic burial chamber in Brittany there are designs presenting a singular likeness to finger-prints, and these carvings may be said to constitute a passage in the unwritten history of men living several thousands of years ago. It is an obscure passage, for there are nearly as many interpretations as commentaries discussing it. One interpretation, backed by an impressive array of evidence showing that counterparts of the figures are to be found in actual finger-prints, holds that they are copies of these natural designs. The implications of the story thus rendered are far-reaching, having even a relation to the question of the origin of decorative design. If it be true that Neolithic men really noted the cutaneous patterns, and with the attention to minute detail which is claimed, credit is due them for a spontaneous interest and keenness in such observation hardly matched by average men of the present day. Accepting the finger-print source of the designs, the question naturally arises as to the purpose of the sculpturing. One "Doctor A.," writing in *La Chronique Médicale*, goes so far as to suggest that the designs are registries of the finger-prints of chieftains, recorded with precisely the object of modern finger-print files, that is, for the purpose of personal identification. These questions anticipate the issue, for the first concern should be the merit of the interpretation of the designs as finger-print motifs.

Neolithic men, in contrast to their Paleolithic forebears, engaged in building. Their success in handling immense stones evokes a deep respect for the engineering of the Stone Age. A stone weighing forty-four tons is thought to have been transported over a distance of nearly nineteen miles to the site of a dolmen at La Perotte. In the neighborhood of the structure which is ornamented with the "finger-print" carvings there lies a broken monument having a total length of over sixty-seven feet and an estimated weight of over three hundred and thirty tons, which is presumed to have been brought to the present site from a point five eighths of a mile distant, then lifted to a vertical position. Neolithic architecture has a definite association with the cult of the dead, many of the monuments, known as dolmens, serving as actual burial chambers. Dolmens are to be found in Europe, Asia and Africa; they number nearly five thousand in France alone. In Brittany there is one which has been described as the finest megalithic monument in the world, and it is this dolmen which bears the "finger-print" gravings. The dolmen is situated on a tiny island, L'Ile de Gavr'inis (Goat



—*Reproduced by courtesy of Professor H. F. Osborn and the Princeton University Press*

FIGS. 1 AND 2. INTERIOR OF THE GALLERY OF THE GAVR'INIS DOLMEN, SHOWING THE CARVINGS ON THE WALLS.

Island), in the Gulf of Morbihan, near Locmariaquer. It exemplifies a form of dolmenic construction termed the passage grave, allée couverte, characterized by the presence of an entrance gallery or vestibule leading to a widened compartment. The Gavr'inis dolmen has an entrance gallery forty-one feet long and about four and one half feet wide, the terminal chamber enlarging to a cubicle almost twice the width of the entering passage and having a height of nearly six feet. The walls are constructed of twenty-nine upright stones, and the whole is paved and roofed by slabs. The structure is imbedded, characteristically, within a low broad mound of earth, or tumulus. When the

dolmen was explored in 1832 it was found despoiled of movable contents. The impressive feature of the interior consists in the sculpturing of the walls with incised lines, fashioned into designs of great variety. It is worthy of note that the carvings are confined to the slabs of granite, two quartz uprights being unmarked. The cutting could have been accomplished with stone tools, though it is possible that implements of bronze were employed.

The photographs shown in Figs. 1 and 2 illustrate the general appearance of the sculpturings, as well as their size in relation to the dolmen. Fig. 3 contains several detail drawings of the designs. Concentric systems of horseshoe form, concentric subcircular figures, spirals, arching lines, sinuous lines, straight lines and other markings occur in various combinations.

Stockis, a distinguished authority on finger-prints, is the chief proponent of the interpretation which identifies the Gavr'inis carvings with the cutaneous patterns, holding that these natural designs served as models for the man-made designs on the stones. He points out that more or less exact counterparts of many features of the carved designs occur in the finger-prints of modern men. Not only are the patterns of the finger tips represented, but in two instances the portion of the palm near the wrist is reproduced. Stockis presents seventy-nine figures to substantiate this statement, illustrating actual prints in parallel with the carvings which they resemble. He directs notice, further, to the occurrence of interruptions, bifurcations and similar details of the sculptured lines, in support of the contention that the sculptures are faithful even to the degree of picturing the finest details of the single skin ridges. Continuing, he emphasizes that men of the Stone Age might readily have been attracted by finger-prints impressed in clay in the process of pottery making. The plasticity of clay favored the development of decorative art, and it has been suggested by Franchet and others that decorative carving was inspired by the designs of finger-prints in clay. Very simple designs were used in decorating the earliest pottery, imprinted with strings or bits of coarse-meshed textiles. Sometimes semilunar indentations were made with the finger-nails and the clay was pinched between the fingers in modeling. In the course of these manipulations the artisans may have become familiar with the finger-tip patterns. Apparently accidental impressions of the fingers occur on many specimens of ancient clay objects; it is said that Faulds, the pioneer English student of finger-prints, was led to this study through an interest stimulated by the observation of such prints in examples of prehistoric Japanese pottery. Finger impressions have been noted on old Roman vessels, on Assyrian bricks of the dynasty of Sargon, the adobe bricks of Mexican funeral mounds and in other primitive ceramics. But, to interpolate, these instances and their modern parallels only illustrate that the manufacture of clay objects is a possible medium for directing attention to the arabesques of the fingers, which might otherwise escape notice. The sign of the hand, whatever its signification, is regarded by Stockis as a possible source of meaning in the "finger-print" carvings, the patterns deriving a significance from their situation on the hand. The hand is thought to have had a religious or symbolic association, its representations being wide-spread in primitive art. One figure is known, indeed, in which rude designs are drawn within the outline of a hand, portraying in rough fashion the finger-tip patterns and "lines" of the palm. This example is one of a series of undated stone carvings, found in Nova

—*From Stockis, Anthropologie, vol. 31, 1921*

FIG. 3. A SERIES OF DETAIL DRAWINGS OF THE "FINGER-PRINT" CARVINGS ON THE UPRIGHT STONES OF THE DOLMEN.

Scotia, representing the open hand, joined hands, crossed fingers and the like.

Stockis, thoroughly convinced that the designs in the Gavr'inis dolmen are finger-print copies, believes that the interpretation applies likewise to similar carvings in the Irish dolmens of New Grange, Lough Crew and Douth, as well as on stones of the Island of Edey. Pointing out that the decorations of ceramics found in dolmens often take the form of concentric designs, he suggests that these and the familiar spiral decoration which has persisted throughout the ages may also have had their birth in the observation of skin patterns.

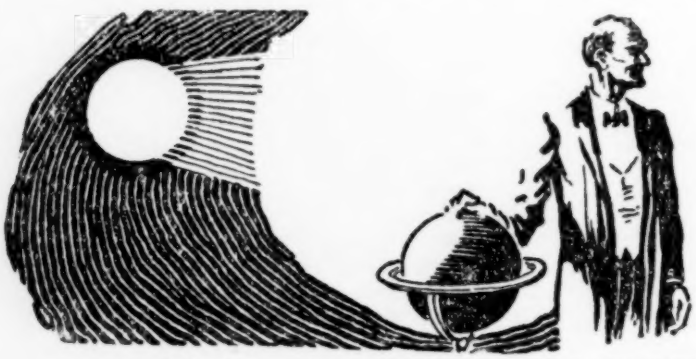
Before passing to other explanations of the Gavr'inis carvings it is well to review the varieties of designs which are found in the Breton dolmens other than those falling into the class resembling finger-prints. Closmadeuc arranges the carvings in a descriptive classification with seven divisions: a simple cavity hollowed in the rock (cupuliform sign); in the form of a curved rod (pediform sign); yoke-shaped (jugiform sign); comb-shaped (pectiniform sign); in the form of an ax-head (celtiform sign); shield-shaped (scutiform sign); in the form of an ax with handle (asciform sign). The meanings of some of the carvings are naturally obscure, though suggested explanations are not lacking. The sign of the chieftain's ax, for example, is definitely a reproduction of the ax which is known from actual examples. It is an abundant design at Carnac, and le Rouzic points to its frequency as an indication that to this burial place were brought the bodies of chiefs. The pediform sign has been interpreted as the representation of a stalk of grain. In describing a group of these figures carved on the stone of a Breton dolmen H. F. Osborn writes: "It shows four rows of single stalks of wheat—with a representation of the sun in the center—bowing their heads like the sheaves of wheat in the story of Joseph." The pediform sign has been compared also with the representation of the ax handle. It is not surprising that the much more elaborate sculptures of the Gavr'inis dolmen have received inconsistent interpretations. Both Osborn and le Rouzic associate these figures with the grain-stalk identity of the pediform sign, asserting that they are conventionalized symbols of the wheat field. Among other proposed interpretations it may be mentioned that the carvings have been explained as Druid symbols, as alphabetical signs, and some of the undulating lines have been thought of as symbols of a snake-worshiping cult. Another view regards the carvings as purely decorative effects, without attempting to trace their origin. Discussion of the relative merits of these views has no place in the present account, concerned as it is solely with an examination of the evidence relating to the finger-print interpretation.

The validity of the argument as to the opportunities afforded in pottery-making for display of the finger-prints must be granted. It is to be recognized also that many elements of the carvings are highly suggestive of finger-prints and that an importance may have been ascribed to their patterns by prehistoric men on account of the association with the hand. But the deduction of finger-print identity of the designs is open to question, for the resemblance may be merely a parallelism or convergence. Much has been written on the subject of designs in nature. It is not difficult to find fairly close replicas of the features of the cutaneous patterns in other natural objects, such as rippled water, rippled sand, the grain in woods and some rocks, erosion configurations,

bandings of color in animals, the shells of mollusks. Men of the Stone Age, like ourselves, were surrounded by countless designs in nature, and their range of observation would have been limited only by individual activities and interests. Conceding that all artificial designs, however combined or transmuted, must have their ultimate source in nature, it is still difficult if not impossible in many cases to trace the designs to their source. Certainly it appears unwise to express with positiveness any interpretation of the origin of the Gavr'inis figures.

Chance duplications of the cutaneous features are to be found in artificial designs, and a remarkable instance of this parallelism will be cited in illustration of the point that caution must be exercised in accepting the finger-print interpretation of the carvings. There appeared recently in the press, accompanying a verse by Edgar A. Guest, a cut which would attract the immediate attention of one who is interested in finger-prints. The illustration, reproduced here in Fig. 4, has a background of arching lines. The curvature of the system is such that it has the appearance of an actual finger-print from which the central area is cut away. The design, in fact, proves to fit exactly several finger-prints enlarged photographically to the same scale. Close inspection of the single lines shows, moreover, that they display certain of the features which are characteristic of skin ridges, forkings and reunions. Is the design a finger-print copy? The artist, Mr. Hubbell Reed McBride, has been very kind in supplying information with regard to the drawing, which makes it possible to use the figure as a modern test case of the argument of resemblance. The points of similarity to a finger-print are striking, yet it can not be maintained that the artist based the design upon finger-prints, for his own statement to the contrary is available. In the face of this instance it seems all the more unwise to make positive assertions respecting the quasi-finger-prints of the Gavr'inis dolmen.

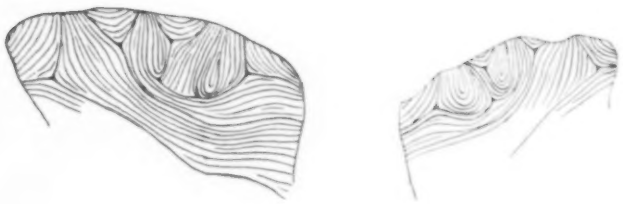
It will be recalled that Stockis lays much emphasis on the fidelity with which the men of Gavr'inis reproduced the details of the skin ridges with their forkings, interruptions, etc. These features in the carvings, however, may be simply adaptations to the curvatures of the incised lines and the interstices of the figures, rather than representations of the cutaneous details. Corre-



—Reproduced by courtesy of the artist, Mr. Hubbell Reed McBride, and the George Mathew Adams Service

FIG. 4. A RECENT ILLUSTRATION

CONTAINING A BACKGROUND WHICH CLOSELY RESEMBLES A FINGER-PRINT, YET WHICH WAS DRAWN WITH THE INTENTION MERELY TO SECURE "A GRAY TONE WITH A DECORATIVE EFFECT."



—*From I. W. Wilder, Journal of Morphology, 1949*

FIG. 5. TWO DRAWINGS OF PORTIONS OF PALMS

WITH THEIR CUTANEOUS PATTERNS, ILLUSTRATING THAT FEATURES CORRESPONDING TO THE INTERRUPTIONS AND BRANCHINGS OF THE GAVR'INIS CARVINGS ARE INCIDENTAL TO THE FILLING IN OF IRREGULARLY CURVED SYSTEMS OF LINES.

sponding details appear in Mr. McBride's drawing. He writes that he frequently employs the line technique to secure "a gray tone with a decorative effect." In studying the drawing, as well as samples of the same technique in which the lines are straight rather than curved, it appears that the forkings are inserted in the effort to produce reasonably equidistant lines within an irregularly curved system. The sculptured designs shown in Fig. 3 exhibit numerous illustrations of a like adaptation of the details of the incised lines to the systems which they compose. If further evidence is needed to show the fortuitous nature of the branchings and related details there are many drawings in the literature relating to skin patterns (dermatoglyphics) which bear witness on the question. It may be explained that in morphological studies of the dermatoglyphics, unlike the application of prints in personal identification, the finer details of the single ridges are in general of minor importance. The investigator who makes a line drawing of the configurations of a palm, for example, needs only to trace a limited number of guide lines from the actual print; he then fills in the intervals with lines illustrating the forms of the patterns, in which reproduction of the ridge details is unnecessary. To fill in the patterns within the limits prescribed by the guide lines, with their highly variable curvatures, the frequent insertion of forkings and interruptions is inevitable. An example of this type of drawing is presented in Fig. 5. Stockis justly objects to an earlier expression of opinion that corresponding details of the Gavr'inis carvings are due to lack of skill on the part of the sculptors, insisting that they were carved intentionally. There is evidence of skilful use of the carving tools, hence the question narrows to whether intention was directed to the reproduction of details present in skin ridges or merely to the construction of continuously lined designs, which entailed the introduction of these filling details.

As a whole the Gavr'inis carvings give the impression of heterogeneity. Among the figures which may be likened to cutaneous patterns there occur many features which bear no resemblance to them. But is it not possible that all are inspired by a single primary motif, and that the apparently foreign designs are simply variations? However this may be, sound evidence that the carved designs had their origin in finger-prints appears to be wanting.

DR. FREDERICK ORPEN BOWER

EMERITUS PROFESSOR OF BOTANY AT THE UNIVERSITY OF GLASGOW, PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE PROGRESS OF SCIENCE

THE BRISTOL MEETING OF THE BRITISH ASSOCIATION

WHEN the British Association meets in Bristol from September 3 to 10, it will do so for the fourth time in that city. At the first meeting there, in 1836, Lord Northampton, a vice-president, laid the foundation stone of Clifton Suspension Bridge. It is a tribute to applied science in one direction that the association has been intimately connected with the construction of two of the world's famous bridges, for after the meeting in South Africa in 1905 the then president, Sir George Darwin, opened the railway bridge over the Zambezi below Victoria Falls.

Bristol is an attractive center for a meeting of the association. Its own industries are varied; its site, and the country surrounding it, are full of geographical, geological, archeological and historical interests. It is necessary only to mention the close proximity of Bath, Gloucester, Cheltenham, Glastonbury and Wells, the Mendip Hills with the well-known Cheddar Caves, the Forest of Dean, and the gorge of the river Avon which still gives access to the port of Bristol for the smaller ships, though the bigger ships must now lie at the outports of Avonmouth and Portishead where the river joins the Bristol Channel.

All the sections of the association will be in full activity as usual. There are associations "for the advancement of science" in other countries, which have formed a much larger number of sections than the British Association, some meeting only to deal with special topics. The British Association permits its sections to form, if they want, special departments to do this—on the present occasion there will be in session a department of mathematics under the section of mathematical and physical sciences, and a department of forestry under the section of botany. But otherwise the sections range widely within their own divisions of science: in the Bristol program, for instance, we find the chemical section (to take a single example) announcing successive discussions on chemotherapy and the British dyestuffs industry.

In reviewing a British Association program, with its three hundred lectures, papers or discussions, there is a certain temptation to confine examples to those subjects of applied science which are intelligible to the layman and appropriate to the general interests of the day. Professor F. O. Bower, however, who will assume the presidency of the association in succession to Sir Thomas Holland, will deal in his address over the whole advancement of science, which he has made his own, namely, "Size and Form in Plants." Those presidents who in the past used to range over the whole advancement of science and in doing so occupy the rostrum far longer than the present generation would endure, sometimes in spite of that left an impression of sketchiness which their own erudition could not wholly remove. The presidential address to the British Association nevertheless maintains its place as the year's most important public pronouncement in science, and botany, which has not for some years been represented in the president, will now be so most properly and notably when Professor Bower details, as he only can for the understanding of the general audience who will hear him, the results of his own prolonged researches.

The sections of botany and zoology will both be impressed by their respective presidents, Dr. W. T. Calman,

of the British Museum of Natural History, and Dr. A. W. Hill, director of the Royal Botanic Gardens, Kew, in their addresses, with the importance of the taxonomic outlook in those subjects. The agricultural section will hear an address on veterinary science from a South African president, Dr. P. J. du Toit, to whom at the meeting in South Africa last year the section owed much for its success. The facts that the section, among other topics, will discuss fertilizers and that one of the evening discourses to the whole association will be given by Dr. R. E. Slade on "The Nitrogen Industry and our Food Supply," give rise to the recollection that it was at Bristol in 1898 that Sir William Crookes delivered his presidential address to the association which contained the classic prediction of a world-shortage of wheat unless agriculture should enlist the aid of chemistry. Geologists will find much field-work to interest them around Bristol. Their section will combine with those of geography and anthropology in a full discussion of the relations between past pluvial and glacial periods.

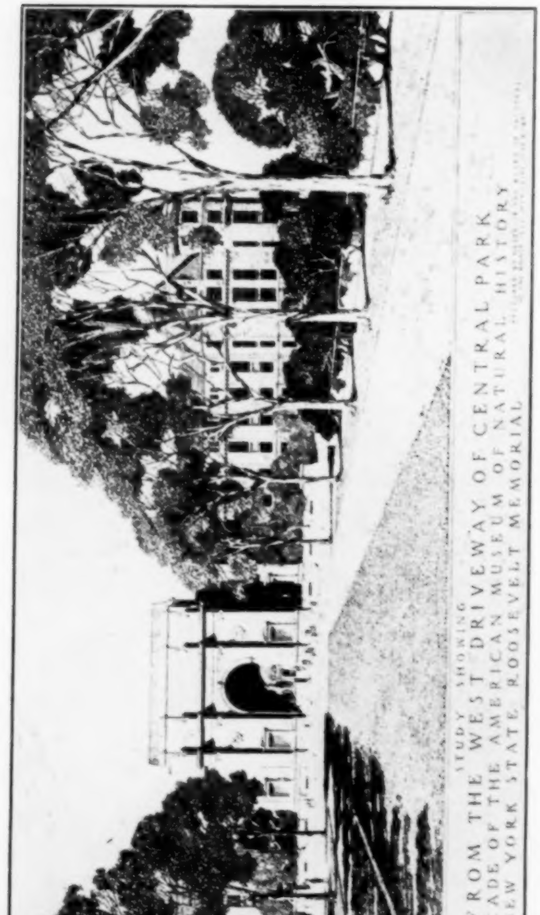
The anthropological section will discuss the important topic of a national folk-museum; and it will hear Miss Caton-Thompson on the investigation which, undertaken last year at the instance of the association, demonstrated to all save the incurable romanticists the medieval status of the ruins at Zimbabwe in Rhodesia. The educational section will receive an address from Lord Eustace Percy, a former president of the Board of Education, on "A Policy of Higher Education," and, following the customary arrangement of its program, will discuss groups of communications on outstanding current topics in education, such as the central schools. The section of economic science and statistics has as its president Professor T. E. Gregory, whose address will deal with "Rationalization and Technological Unemployment," and it is understood that leading representatives of the section will take part in an afternoon meeting arranged during the association's week by the management research groups. The geographical section will consider a topical subject in receiving certain communications on town-planning. A similar and not unrelated subject is that of national parks, which will be appropriately dealt with at a conference of delegates of corresponding societies, which are local scientific societies all over the country, whose interests and activities might well be used, and in some instances are used, in the direction of the preservation of rural beauty and scientific interest.

"Wireless" inevitably plays its part in the meeting: the British Broadcasting Corporation will stage an educational exhibit; Professor E. V. Appleton will give an evening discourse on "Wireless Echoes"; and the section of mathematical and physical sciences will discuss the meteorological relations of atmospherics. The section will have the advantage of meeting and witnessing demonstrations in one of the finest physics laboratories in the country, that of the University of Bristol (in which most of the association's work will be centered).

Public lectures—those, that is, to which the public and not only members of the association are admitted—have been asked for with unusual and gratifying freedom, not only in Bristol but also in neighboring towns. Among such lectures in Bristol, Sir Arthur Keith will speak on the debt which modern anthropology owes to a famous former citizen of Bristol—Dr. John Beddoe, and Sir Daniel Hall will interest the local fruit-farming industry concerning research on apples.

DR. WILLIAM T. G. MORTON

A BUST PRESENTED TO THE MASSACHUSETTS GENERAL HOSPITAL, BOSTON, BY THE ASSOCIATED ANESTHETISTS OF THE UNITED STATES AND CANADA. IT WAS DR. MORTON, A BOSTON DENTIST, WHO FIRST DEMONSTRATED PUBLICLY THE ANESTHESIA CAUSED BY SULPHURIC ETHER IN A SURGICAL OPERATION ON OCTOBER 16, 1846. THIS BUST, DESIGNED BY CLARK MILLS AND EXECUTED BY TIFFANY, SHOWS MORTON AS HE IS BELIEVED TO HAVE LOOKED IN 1846. THE BUST IN THE HALL OF FAME OF NEW YORK UNIVERSITY SHOWS MORTON IN THE UNIFORM OF A CAVALRY OFFICER IN THE CIVIL WAR NEARLY TWENTY YEARS LATER.



—*Courtesy of the American Museum of Natural History*

THE NEW YORK STATE ROOSEVELT MEMORIAL AND THE EASTERN FAÇADE OF THE AMERICAN MUSEUM OF NATURAL HISTORY FACING CENTRAL PARK

THE NEW YORK STATE ROOSEVELT MEMORIAL

THE splendid memorial to Theodore Roosevelt which is to form the central portion of the east façade of the American Museum of Natural History was first brought to public attention by the suggestions of the press in 1919. By December of that year a memorial to the great president had gained wide acceptance and met with the approval of Mayor Hylan and Governor Smith, as well as many leading citizens of New York.

At the time, Governor Smith advised Professor Osborn that it had become a matter for legislative action, and in 1920 the legislature passed "An Act creating a commission to investigate and report on the proposed memorials to Theodore Roosevelt, and making an appropriation therefor."

The work of the commission proceeded steadily, and in 1924 the legislature passed an act providing for the erection of the memorial in New York City "as a free public education building and made an appropriation for expenses." As now amended, the act provides that the memorial shall be erected at a cost to the state not to exceed $3,500,000.

In October, 1924, Governor Smith named the following trustees: Professor Henry Fairfield Osborn, chairman; Mr. Peter D. Kiernan, vice-chairman; Mrs. Douglas Robinson; Mrs. William H. Good; Mr. Chauncey J. Hamlin; Dr. Charles W. Flint and Mr. Sullivan W. Jones.

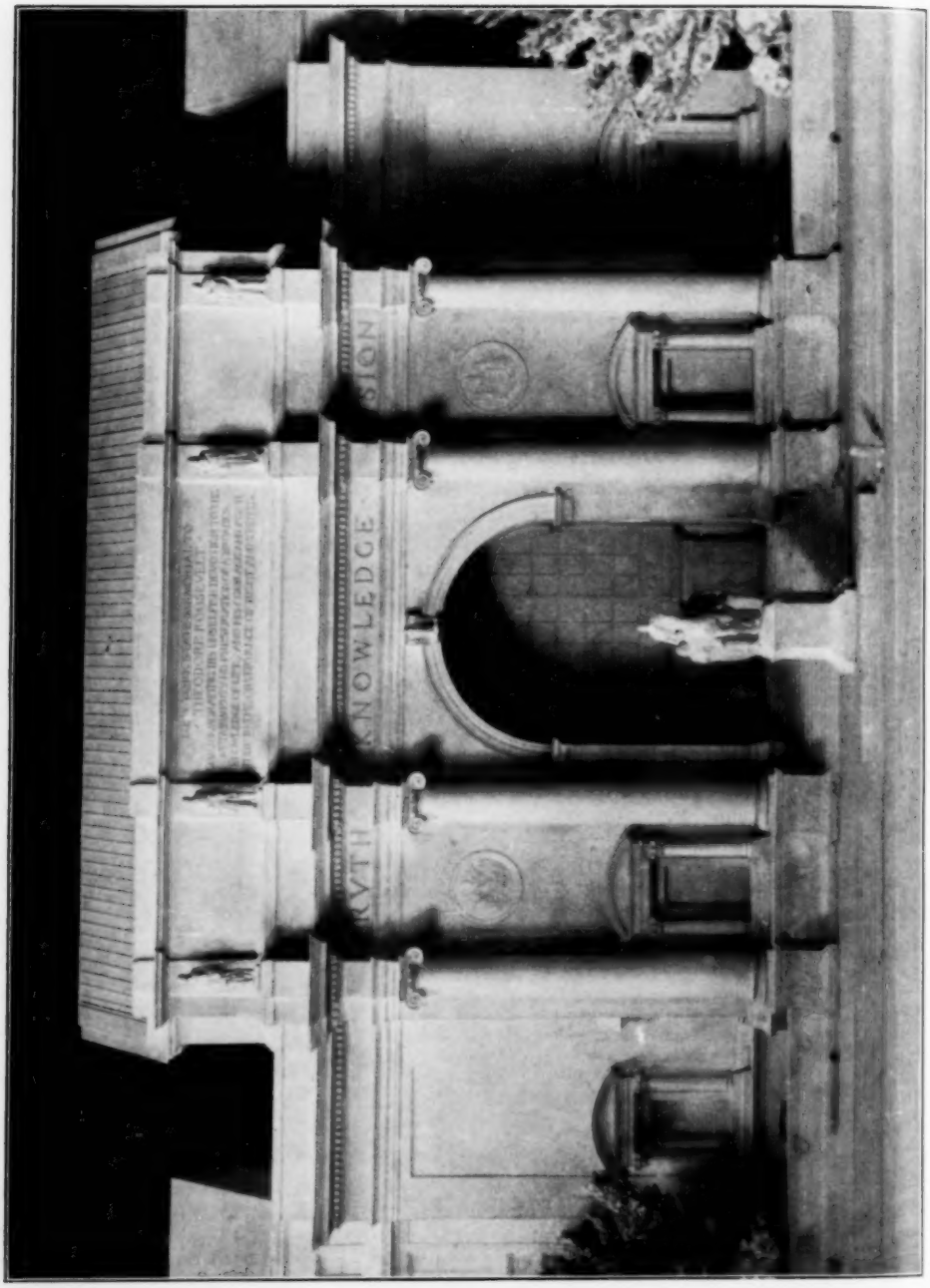
In 1925, the trustees invited a competition of the leading architects of the state, and the prize was awarded to John Russell Pope, of New York City. Mr. Pope entered on this work with enthusiasm, and on July 26, 1926, the plans and specifications were ready for the award of the first contract.

Since that time the trustees have carefully studied the requirements of public buildings in order to establish every convenience for the hosts of visitors who, it is hoped, will find in this memorial the inspiration to emulate those qualities of courage, honesty, dignity and humanity which were exemplified in the life of Theodore Roosevelt.

In planning the external features of the memorial, Mr. Pope turned to the stately architecture of the Roman Empire and found a suggestion for the façade in the triumphal arches of that brilliant civilization. This triumphal motive, with lofty arches reaching sixty feet above its base, flanked on either side by huge granite columns supporting heroic figures representing different phases of Roosevelt's life and crowned by a solid, simply inscribed parapet wall, not only symbolizes the great spirit of Theodore Roosevelt, but echoes the dignity of the state and the nation.

The paved granite terrace, fully 350 feet in length, flanked at both ends by huge pedestals carved in bas relief, supplies a fitting setting for the façade. This is reached by a short flight of steps from the sidewalk. Adjoining both ends of this terrace and encircling it to the rear, a vehicular driveway leads on a gentle slope to the first floor entrance. In the center of the terrace, immediately in front of the great arch, will arise a polished granite pedestal bearing an equestrian statue of Roosevelt with two accompanying figures on foot, one representing the American Indian and the other the primitive African. This heroic group will attain a height of thirty feet above the sidewalk, and, proceeding as in triumph from the lofty arch, will symbolize the fearless leader, the explorer, the benefactor and the educator. This group, it is hoped, will inspire the beholder with a sense of the all-pervading spirit of human adventure and benevolence.

On both sides of the steps leading to the entrance archway will be deep



FAÇADE OF THE ROOSEVELT MEMORIAL.—*Courtesy of the American Museum of Natural History*

—*Courtesy of the American Museum of Natural History*

ENTRANCE HALL OF THE ROOSEVELT MEMORIAL

niches displaying sculptured groups. Overhead there will be a richly coffered vault, while directly in front is a mammoth screen, a composition of bronze, glass and marble. This screen is to form the background of the great archway and provides a means of direct lighting to the interior, affording a comfortable vestibule to the building, at the same time conveying a true impression of the grandeur of the interior beyond.

The hall itself will be sixty-seven feet wide and 120 feet in length with additional recesses on both sides and at each end. Decorative panels will contain quotations from Roosevelt's writings and join the ensemble in paying tribute to his greatness. The floor will be richly patterned in marble mosaic design. The walls, to a height of nine feet, will be of marble, above which mellowed limestone will extend to an elaborately modeled Corinthian cornice, the whole to be culminated by an octagonal coffered barrel vault reaching one hundred feet above the floor. At either end of this vault the walls are penetrated by large circular headed windows which, together with the huge grilled opening at the main entrance, will furnish the hall with an abundance of daylight. It is the purpose of the architect that this

FAÇADE OF THE ROOSEVELT MEMORIAL —*Courtesy of the American Museum of Natural History*

great room, planned to typify the out-of-doors, shall not want for brightness and cheer, and shall even admit the sunshine.

Great murals, however, are not best appreciated in such a direct light, wherefore the designer has skilfully placed them in the recessed walls at the three sides of the room. Guarding these recesses and supporting the vault overhead, are marble shafts, or columns, sixty feet high. The columns, crowned by ornate Corinthian capitals, and executed in deep, antique red marble, stand as sentinels to the distinction of the man, and lend a note of virility and strength so characteristic of Roosevelt.

To the right of the entrance will be placed the administrative offices and the trustees' room. On the left will be a group of rooms superbly finished in panelled wood, forming a suite reserved for the use of the Governor upon his official visits to the city.

On the axis of the great hall, monumental doorways with massive bronze doors will lead directly into a wide, encircling corridor. This corridor, while containing mementos and relics of Roosevelt, provides spacious connection with the present and future wings of the museum, to the stairways and elevators, to the class and educational rooms, and to the laboratories. The doorway opposite the main entrance connects also with the future Akeley Hall, a hall planned by the late Carl E. Akeley to retain for future generations a knowledge of the fast vanishing African life. During Mr. Roosevelt's lifetime, Mr. Akeley was his coworker and companion on many of his hunting expeditions. It is a most felicitous circumstance that this relationship should be perpetuated through this lasting association of mementos.

The southerly end of the memorial building will be joined by the new building containing splendid collections of Asiatic mammals, with an unexcelled series of fossil reptiles of ages long gone by, which never lose their fascination for the visitor. On the north, a hall will be erected which will house a collection of ocean birds and those inhabiting islands of all parts of the globe. Thus these structures devoted to natural science, with which Roosevelt's name is most closely identified, will fittingly surround the great structure raised in his memory.

GEORGE N. PINDAR,
Secretary